THE STUDENT'S TEXT-BOOK OF SURGERY

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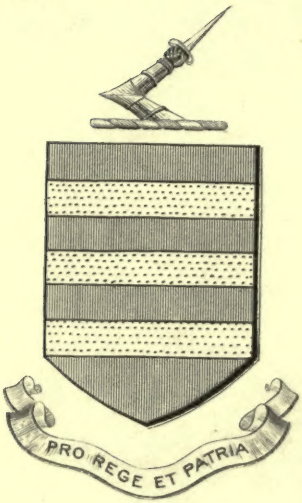

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THE STUDENT'S TEXTBOOK OF SURGERY

ACCIDENTAL INJURIES TO WORKMEN

WITH REFERENCE TO THE WORKMEN'S COMPENSATION ACT, 1906

BY

H. NORMAN BARNETT, F.R.C.S.

WITH ARTICLE ON

"INJURIES TO THE ORGANS OF SPECIAL SENSE"

By the late CECIL E. SHAW, M.A., M.Ch., M.D.

AND

LEGAL INTRODUCTION

By THOMAS J. CAMPBELL, M.A., LL.B., Barrister-at-Law.

DEMY 8VO. 7S. 6D. NET

Lancet: "The book is a valuable contribution to medical and legal literature; it should be possessed by everyone who is likely to be engaged in cases coming under the Workmen's Compensation Act."

LONDON: WILLIAM HEINEMANN

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THE STUDENT'S TEXTBOOK OF SURGERY

BY

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LONDON
WILLIAM HEINEMANN

LONDON: WILLIAM HEINEMANN. 1916.

To

MY MOTHER

PREFACE

In writing this work the requirements of the student have been chiefly thought of, but the oft-quoted busy general practitioner will, nevertheless, find in it all that he is likely to require to help him in the surgical part of his practice.

For the first time in a student's manual of surgery all the sections on special allied subjects have been written by recognized teachers of those subjects. The student has thus the advantage of having in one textbook of surgery the teaching which he has usually to seek in several books. The importance of elaborating some of these subjects by specialists for the benefit of the student is increasingly evident in these days, since many schools now require separate certificates, and in some cases an examination, in such subjects.

The book has been arranged in such a way as it is believed will best meet the needs of the student, and render the subject most easy and attractive. Those special subjects, such as Bacteriology, Blood-Therapy, etc., reference to which must frequently be made in the pages of a modern textbook of surgery, are placed first; while such subjects as the Surgery of the Special Senses are placed in the most suitable sequence so as not to break in upon the uniformity of the text. Tabulation where practicable has been adopted.

Some surprise may be felt at the inclusion of Genito-Urinary Diseases in the Female, and the Surgical Aspect of Infective Fevers. The former has been inserted since it would appear rational that the student should learn of those conditions on which he is examined in their proper place under Genito-Urinary Surgery, and not have to go to a separate text-book for his information. The latter subject has been introduced owing to our increasing knowledge of the surgical importance of the complications of certain fevers, and because many students do not seem to grasp the connection between them.

Syphilis and Gonorrhœa have been placed immediately after Genito-Urinary Diseases, and not under Specific Surgical Affections, for the reason stated in the chapter on those conditions.

Deformities from whatever cause arising have been treated as a whole

in one section instead of scattered through the work; the student thus gets a much more comprehensive view of the subject.

Description of details of operations has been omitted, except where necessary for the elucidation of the context. The usual sketchy paragraphs devoted to the subject in many manuals of surgery are quite useless to teach operative surgery, which should be learnt from one or other of the excellent special textbooks.

For a similar reason Surgical Anatomy has been omitted, with the exception of a brief description of the female genitals.

When a pathological condition is the direct outcome of a previously existing one, it is placed as a possible result, thus, suppuration and abscess are not treated as separate subjects, but as a possible consequence of inflammation.

The work has been rendered brief, where brevity does not interfere with clearness of statement. Academic discussion and padding have been omitted.

I am much indebted to the various specialists who have contributed to the work, and also for the way in which they have carried out the scheme laid down.

Thanks are due to the Museum Committee of Belfast University for permission to use many valuable specimens as illustrations, which have been specially prepared for this work and never before published.

Also to many friends for advice and help from their published and unpublished work, and for permission to use specimens for illustration.

I have in this connection to specially thank Dr. L. Jones Lewellyn for the loan of blocks of coloured illustrations from his work "Fibrositis."

It is hoped that all will accept this acknowledgment where specific reference is not made in the text.

For help in revising proofs I am indebted to Surgeon de v. Blathwayt, R.N., and to Captain Scovel Soden.

Messrs. Down Brothers and John Weiss and Son have kindly given permission for the use of some of their blocks.

Finally, thanks are due to Mr. Heinemann, who took the work over from Messrs. Rebman, for his care in production and for the liberal allowance of illustrations.

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THE STUDENT'S TEXTBOOK OF SURGERY

CHAPTER I

INTRODUCTORY

THE history of modern surgery is almost a romance. It has advanced by rapid strides from the obscurity which, as it was practised, it merited to be, perhaps, the most scientific and the most complicated branch of modern medical science. This very progress has borne hardly upon the medical student, for it has created a vast field of study, and has, in turn, given rise to many branches of surgical science.

The modern surgeon is not one who merely knows where to make various incisions and how to carry out certain operative procedures; he must, to be truly successful, be a man of wide culture, highly developed brain, and sympathetic nature.

As the student approaches the study of the subject, he should remember that it is one of comparatively recent advance, which is still advancing; he should banish from his mind the "cocksureness" too much in evidence in the student and the junior house surgeon, and adopt a somewhat more reverent attitude.

The student stands to-day in the light of the aseptic methods, having passed from the night of surgical sepsis through the dawn of the antiseptic method, guided by the genius of Lister.

From what the student sees in the practice of a great hospital, he may be tempted to think that he need not pay much heed to his unaided powers of diagnosis, since the pathologist, the radiographer, the bacteriologist, and the hæmatologist, stand ready to aid him.

No mistake could be more fatal than to rely on any one of them to replace clinical diagnosis, for on it must be placed most reliance

The various specialists are most useful to clear up and verify diagnosis, but they should never be looked to for the correction of a slipshod clinical examination and faulty powers of deduction.

The average student should also remember that such helpers as are to be found on a hospital staff, or are available in a large city, will not always be at his side. He will, therefore, be well advised if he determine as student, or clinical clerk and dresser, to make use of his powers of observation, and to "worry out" a case for himself at the bedside or in the out-patient department, using laboratory methods when he can do so to prove his diagnosis correct. Nor must it be forgotten that the laboratory is not infallible, and frequently the clinical diagnosis has been proved to be the correct one rather than

that of the laboratory. Pearce Gould has well said that "the process of diagnosis consists, first, **in observation of the facts of the case, and, secondly, in the interpretation of these facts.**"

Note-Taking.—The taking of notes is regarded by the student as quite an unnecessary tax upon his time; but he will find it a most valuable help to him in dealing with a case to have a clear knowledge of the patient's family and personal history, and to know and observe his present condition.

Family history is especially valuable with regard to **tuberculous** and **syphilitic** conditions; personal history with regard to **alcoholism** and **syphilis.** When records of these conditions are not elicited, the histories, family and personal, should still be carefully taken, and diagnosis helped by accurate observation of the existing condition of the parts affected.

By a process of exclusion it is sometimes possible to arrive at a correct conclusion of what the patient is suffering from, when a case is somewhat confused as to its issues; but it is wiser to make no diagnosis than to make a foolish one, which is not justified by existing signs and symptoms.

Frequently a case which is not easy of immediate diagnosis will become so by observation, and there is no mistake more frequently made by the student and young practitioner than to think that it is disgraceful not to come to an immediate conclusion about a case. From an examination point of view, of course, a diagnosis will be expected; but obscure and difficult cases are not as a rule chosen for the purposes of examinations, and the student will do well to bear this in mind, as it sometimes happens that a candidate is so obsessed with the idea that some very difficult case is presented to him that he misses the obvious diagnosis, and lands himself in an academic discussion about a supposed rare and exceptional condition.

Difficult and wide as the science of surgery is, there are certain broad defined lines of quite simple observation and deduction, which, combined with good judgment, will go a long way to help the student in its study and practice.

Surgical disorders may be—

Congenital.—This means that the condition has been acquired during intra-uterine life, or is due to developmental errors; such are congenital hernia and hydrocele, congenital dislocation, undescended testicle.

Hereditary.—This signifies that the disease, or the conditions favouring some special disease or favouring the development of many diseased conditions, has been handed down from parent to child. With the exception of **syphilis,** no disease is actually transmitted, but predisposition is handed down in many instances, as in the case of bleeders, tuberculous subjects, and alcoholics; the latter two transmit not only a special predisposition to a special disease, but also a general predisposition towards disease, or a weakened resisting power.

Acquired.—These develop after intra-uterine life is passed, and are chiefly due to injury as a predisposing or exciting cause, and to infective agents.

It must clearly be borne in mind that many congenital conditions may not become noticeable till long after birth, and frequently do

so then owing to some exciting cause, and so may more truly be considered as acquired conditions, developing because of some congenital defect; such are many hernias. Thus, many acquired disorders are really due to congenital weakness.

Surgical disorders may also be **local** or **general.** Most abnormal conditions, even if localized, produce a certain amount of general disturbance, which may, however, subside completely. This is especially true of certain injuries, such, for example, as a simple fracture, in which, after the initial shock, and when the bone is properly set, there are no constitutional symptoms; although there is a local condition which may be considered abnormal.

CHAPTER II

SURGICAL BACTERIOLOGY

The introduction and rationale of antiseptic surgery—Characters of bacteria in general and of certain common pathogenic varieties—Bacteriological methods of surgical diagnosis.

THE progress which surgery has made during the past forty years is largely due to the light thrown by **Pasteur** on the subjects of fermentation and putrefaction. Pasteur showed that these processes required the presence, and were the result of, the activities of living micro-organisms. **Lister,** appreciating the importance and bearing of Pasteur's work, conceived the idea that the suppuration of wounds belonged to the same class of phenomena, and as a result introduced the antiseptic method of treatment. The principle of Lister's system was to treat the instruments and hands of the operator, as well as the tissues of the patient, with solutions of chemicals (**antiseptics**) in order to destroy all bacteria which might otherwise gain access to the wound, and cause it to fester. Lister's method has undergone numerous modifications and improvements, but the principle on which it is based—namely, that suppuration is due to bacteria—has never been shaken.

These preliminary remarks indicate how important and essential to the surgeon is some knowledge of the bacteria associated with such processes as inflammation, suppuration, ulceration, septicæmia, and gangrene.

Bacteria are minute unicellular vegetable micro-organisms, which are devoid of chlorophyll, and which multiply by a process of fission; on account of this latter quality they have also been called **fission-fungi,** or **schizomycetes.**

Forms of Bacteria.—According to their shape, these micro-organisms have been classified into several groups. Spherical bacteria are known as **cocci.** When these divide irregularly, forming grape-like clusters, they are known as **staphylococci** (Fig. 1, Pl. I.). Cocci which divide along one plane, and the members adhere together forming a chain, are called **streptococci** (Fig. 2, Pl. I.). **Diplococci** are cocci grouped in pairs. When diplococci again divide in a direction at right angles to the previous line of fission, but in the same plane, **tetracocci** are formed. Cocci dividing in three directions in two planes of space, so that cubical masses are formed, are known as **sarcinæ.** Straight or slightly curved, rod-shaped bacteria are termed **bacilli,** and spiral bacteria **spirilla.** A long, flexible spiral is a **spirochæte;** but it is yet uncertain whether the spirochætes belong to the vegetable or animal world. Bacteria which form long, branching threads are called **streptothrices,** and

PLATE I.

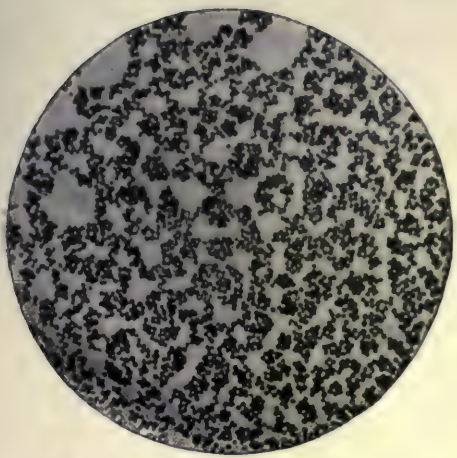

FIG. 1.—*Staphylococcus pyogenes aureus.* × 1000.

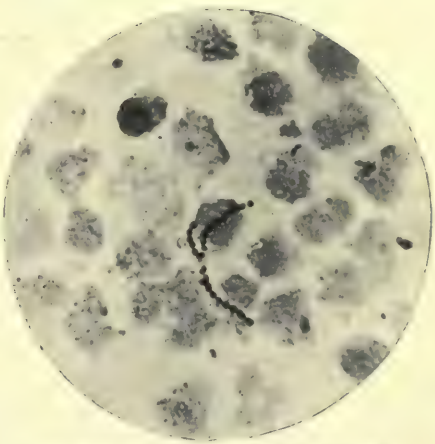

FIG. 2.—*Streptococcus pyogenes* in Pus, Gram's stain. × 1000.

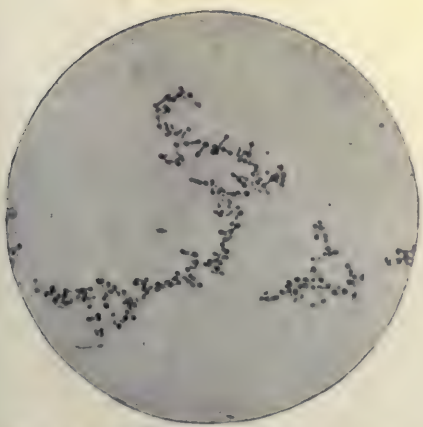

FIG. 3.—*B. diphtheriæ*, Neisser's stain. × 1000.

(From Williams' "Bacteriology.")

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actinomycosis is due to infection with these. Bacteria are extremely minute. A coccus varies in diameter from 0·5 μ to 1 μ,* and the average length of a bacillus is 4 μ.

Staining.—Bacteria are readily stained by watery solutions of basic aniline dyes—*e.g.*, methylene blue. **Gram's method** of staining divides bacteria into two groups. The principle of this method is that iodine fixes a basic stain—*aniline-gentian-violet*—in certain microbes, so that subsequent washing with alcohol is unable to remove the stain. Bacteria which retain the stain under these conditions are called **Gram-positive**, whilst those that part with it are **Gram-negative**. It may be stated as a broad rule that most cocci are Gram-positive and most intestinal bacilli are Gram-negative. Thus *Staphylococci* and *Streptococci* are Gram-positive, whilst the *B. typhosus*, *B. dysenteriæ*, *B. coli communis*, and *B. pyocyaneus*, are Gram-negative. Of Gram-negative cocci, the *Gonococcus* and the *Meningococcus* are the best-known examples, and of Gram-positive bacilli the *B. anthracis*, *B. tetani*, *B. diphtheriæ*, and *B. tuberculosis*, may be cited. Nearly all *Streptothrices* are Gram-positive.

Certain bacteria are, owing to the presence of a fatty envelope, difficult to stain; but when stained by a powerful dye, such as carbol-fuchsin, retain the colour when treated with a mineral acid in strong aqueous solution—*e.g.*, 30 per cent. nitric acid. Such bacteria, of which the tubercle bacillus, the smegma bacillus, and the *B. leprœ*, are well-known examples, are said to be **acid-fast.** Some bacteria also retain the stain after treatment with spirit, and are then termed **alcohol-fast.**

Motility.—Certain bacteria possess the power of moving about freely in a fluid medium. Such motile bacteria possess long, delicate, hair-like processes—*flagella*—attached to their bodies. At times non-motile bacteria—*e.g.*, cocci—exhibit active "Brownian movement," which must be distinguished from true movement of transposition.

Habitat.—Bacteria are widely distributed in nature. They are present in air, water, and soil. Most bacteria of pure air and water are harmless, and the same applies to those of virgin soil. It is the air, water, and soil, which have been contaminated with the secretions and excretions of man and the lower animals, that contain pathogenic bacteria. Bacteria are found in the skin, especially in the sebaceous glands and hair follicles, and in all parts of the alimentary canal.

A dusty atmosphere is especially rich in germs, and the air of crowded rooms contains bacteria sprayed out of the mouths of those speaking in it. The bearing of these facts on the construction and regulation of operating-theatres is obvious.

Multiplication of Bacteria.—Bacteria multiply by **fission.** An individual enlarges until it attains twice its normal length, and then it divides into two separate micro-organisms. Besides this method of reproduction, certain bacteria form spores. **Spores** are round or oval highly refracting bodies, which develop within the bacteria, and which are extremely resistant to destructive agencies—*e.g.*, heat, antiseptics, etc. Fortunately for mankind, most pathogenic bacteria do not form spores. The chief spore-formers are the *B. anthracis*, *B. tetani*, *B. œdematis maligni*, and *B. aerogenes capsulatus*. Spores are formed as a rule when the conditions of life become unfavourable

* μ = micron = 0·001 mm. = $\frac{1}{25000}$ inch.

for the bacterium; when they are brought into a favourable substratum bacilli grow out from them.

Conditions of Growth.—Bacteria can be cultivated in artificial fluid media containing "peptone" dissolved in an aqueous solution of meat extractives, or on similar media solidified by the addition of gelatin or agar. Agar possesses the advantage over gelatin that it remains solid at body temperature (37° C.). Bacteria possessing a proteolytic ferment liquefy gelatin, whilst others are non-liquefiers. Some bacteria—*e.g.*, *gonococcus*, *meningococcus*—require the addition of ascitic fluid or serum to such media to meet their growth requirements. Carbohydrates—*e.g.*, glucose, lactose, etc.—and alcohols—*e.g.*, mannite—are often incorporated with the media in order to determine what fermentative action the micro-organisms have on them, and in this way to differentiate species of microbes. Certain bacteria, termed *obligatory aërobes*, can grow only in the presence of oxygen; others, *obligatory anaërobes*, can grow only in the absence of this gas, whilst the majority of bacteria can flourish either under aërobic or anaërobic conditions, and are known as *facultative anaërobes*. Most pathogenic bacteria can grow at body temperature (37° C.), or at 22° C. A few grow *only* at body temperature. At temperatures higher than 42° C. growth soon ceases. Heating to 65° C. for a few minutes destroys most bacteria. Spores may withstand boiling for some minutes. Prolonged boiling or steaming destroys all forms. This fact has been applied to the sterilization of instruments and dressings.

Sunlight destroys bacteria and even their spores. Many chemical substances are capable, in weak solution, of destroying bacteria; such substances are known as **germicides.** The most important germicides are carbolic acid, many cresols, and the salts of mercury. In very weak solution these may only inhibit growth, and are then said to have an *antiseptic* action. Some substances can be antiseptic without being germicidal.

Toxins.—Pathogenic bacteria produce their harmful effects mainly by means of certain poisons or *toxins* of a complex chemical structure formed by them. Some of the bacteria secrete these substances into the medium in which they are growing; such toxins are called *extracellular toxins*. In other cases the toxin remains confined to the bacterial cells, and only passes into the medium on the dissolution of the cell bodies; such toxins are called *endotoxins*. The *B. diphtheriæ* and *B. tetani* form extracellular toxins, whilst the toxins of the *B. typhosus*, *B. dysenteriæ*, and *B. choleræ*, are endotoxins.

Special Bacteria.

Anthrax Bacillus (Fig. 2, Pl. II.).—This is a large, Gram-positive, non-motile bacillus, which grows readily on the ordinary media, and liquefies gelatin. When there is an adequate supply of oxygen present, spores are formed in old cultures. The spores are oval, and occupy the centre of the bacillus. Spores are not formed inside the body of an infected animal. In man it causes a malignant pustule or a general septicæmia.

Diphtheria Bacillus (Fig. 3, Pl. I.).—This bacillus lies in the fibrinous membrane, to which infection with it gives rise, and from which, without further invasion of its host, it pours its toxins into the blood. In young cultures it appears as a fine delicate bacillus, containing in its interior round granules, which stain differently from the rest of the organism. These *metachromatic* granules can best be demonstrated

PLATE II.

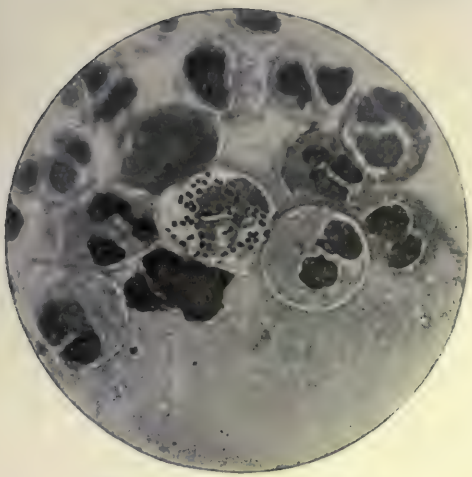


FIG. 1.—Gonococci and Pus Cells. ×1000.

FIG. 2.—Anthrax Bacilli, showing Spores. ×1000.

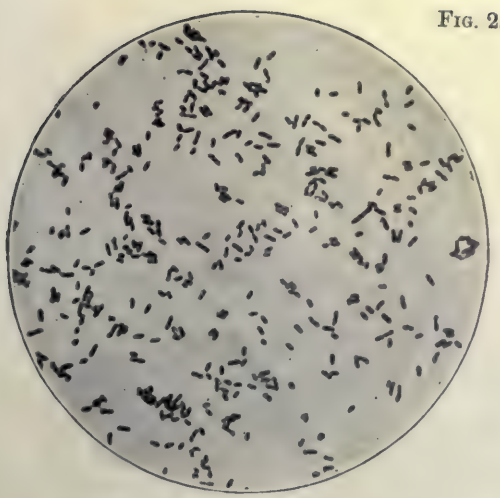


FIG. 3.—*B. coli communis.* ×1000.

(From Williams' "Bacteriology.")

[To face page 6.

by the use of Neisser's stain. In old cultures many of the bacilli become swollen and club-shaped. It is Gram-positive, non-motile, and grows well on inspissated serum. In distinguishing the true *diphtheria bacillus* from *pseudo-diphtheria bacilli* attention is directed to the following points: (1) Presence of Neisser's granules in the diphtheria bacillus in an eighteen hours' culture on solidified serum, whilst these are as a rule absent from pseudo-diphtheria bacilli under the same conditions; (2) the *B. diphtheriæ* forms *acid* in glucose-containing media; and is (3) more pathogenic to guinea-pigs.

B. Tuberculosis is the cause of tuberculous lesions, in no matter what part of the body they may be found. It is a thin rod 3 μ in length, is *acid-fast*, and also *alcohol-fast;* in this latter respect we have an important distinction from the **smegma** bacillus, a harmless acid-fast micro-organism, which occurs in urine, and with which the tubercle bacillus may be confused. The tubercle bacillus does not grow at room but only at body temperature. Glycerine bouillon, glycerine potato, inspissated serum, or egg media, are usually employed for its cultivation. It grows slowly, but finally forms large masses resembling dry, crinkled pieces of yellow parchment.

Anaërobic Bacilli.—Of these the most important are the *B. tetani*, the *B. œdematis maligni*, and the *B. aerogenes capsulatus*, all of which are large spore-bearing bacilli. The spore of the **B. tetani** is globular, and occupies the end of the bacillus, which it swells out, giving to the whole a drumstick appearance.

The *B. œdematis maligni* and *B. aerogenes capsulatus* are the organisms most commonly found in cases of emphysematous gangrene. In culture, as in the body, their development is associated with the formation of gas.

The **B. Œdematis Maligni** in size and appearance resembles the anthrax bacillus, but differs from it in being motile, Gram-negative, and an obligatory anaerobe. Moreover, its oval spore causes a central bulging of the bacillus, which becomes spindle-shaped.

The **B. Aerogenes Capsulatus** in the tissues, as its name implies, is surrounded by a capsule. It is non-motile and is Gram-positive. Spores are not formed in the body, but usually are in the culture media. It is present as a rule in the intestinal canal, and may invade the tissues after death, and these generate gas, giving rise to *foaming* of the liver, etc.

B. Mallei.—Infection with this bacillus gives rise to glanders. It is a delicate bacillus about the same size and shape as the tubercle bacillus. It is not acid-fast, and is Gram-negative. It can easily be cultivated on ordinary media. The growth on potato is most characteristic, the colonies appearing like drops of honey, and then becoming chocolate-brown.

Actinomycosis is due to infection with a **streptothrix** — *i.e.*, a bacterium which forms long, branching threads. There are several varieties of streptothrices, and most of them are Gram-positive. The threads of the organism form little feltwork masses, and arranged around the periphery of these are swellings of the terminal filaments, which, from their shape, are usually called *clubs*, and from their radiating arrangement the micro-organism gets the name **ray fungus.** The filaments stain with basic dyes, and the clubs with such acid dyes as eosin. When the lesions ulcerate, sulphur yellow granules, about the size of a very small pin-head, consisting of masses of streptothrix filaments and clubs, are found in the discharge.

Pyogenic Bacteria.—The bacteria that are of especial surgical interest are those associated with the formation of pus. The chief pyogenic micro-organisms are—(1) **Cocci,** *e.g.*, *Staphylococci, streptococci, pneumococci,* and *gonococci;* (2) **bacilli,** *e.g.*, *B. pyocyaneus, B. coli communis, B. typhosus.*

Staphylococci are the most important pus-producing micro-organisms. They can be readily cultivated on the ordinary media, and according to the colour of the growth certain varieties are recognized. The *Staphylococcus aureus* and *S. citreus* produce orange and yellow pigment respectively, whilst the colonies of the *S. albus* are opaque white in colour. Staphylococci are 0·5 μ in diameter, and stain by Gram's method. They liquefy gelatin, and the presence of this proteolytic ferment accounts for the digestive action which these micro-organisms have on the tissues. These cocci are found in acute abscesses, suppurative osteomyelitis, septicæmia, and pyæmia. Staphylococci, especially of the *S. albus* class, are normally found in the superficial layers of the skin.

Streptococci are Gram-positive cocci, 0·5 μ to 1 μ in diameter, which grow in chains. In culture these cocci form very minute colonies, which are not pigmented. They do *not* liquefy gelatin. Several varieties of streptococci are recognized, which have, among other means of distinction, their fermentative action on sugars, alcohols, and glucosides. The *Streptococcus pyogenes* is the most important, and has been found as the causative agent in malignant endocarditis and septicæmia, but shows a special tendency to cause lymphangitis and cellulitis. The **pneumococcus** is a special variety of the streptococcus class. It occurs as lanceolate Gram-positive diplococci, surrounded by a capsule. Serous membranes are particularly apt to be attacked by it, and so it is often found in the pus of cases of inflammation of the pleura, peritoneum, and meninges.

The **Gonococcus** (Fig. 1, Pl. II.) is a Gram-negative diplococcus, which is found mainly inside the cells in gonorrhœal discharges. It requires the addition of serum to the ordinary media to obtain cultures. In the above respects it resembles the **meningococcus** (*Micrococcus intracellularis meningitidis* of Weichselbaum), which causes epidemic cerebro-spinal meningitis. The action of these diplococci on maltose helps to differentiate them. Of all the common carbohydrates, alcohols, and aldehydes, the meningococcus ferments only maltose, glucose, and dextrin, whilst the gonococcus cannot ferment maltose, but does ferment glucose.

Bacillus Pyocyaneus grows readily in the ordinary media, and in them produces a green colouring matter. It is actively motile, and is very similar in appearance to the *B. typhosus.* It is the cause of the colouration of blue or green pus.

B. Coli Communis (Fig. 3, Pl. II.) is a short, feebly-motile bacillus, found normally as an inhabitant of the intestine. It is commonly found in the pus of most cases of peritonitis, and of suppurative appendicitis. It is also frequently the causal organism in cases of primary cystitis and pyelitis. In a pyelitis or cystitis with an acid urine, the infecting microbe is generally either the *B. coli communis* or the *B. tuberculosis.* The *B. coli communis* grows readily on nutrient agar and gelatin, the growth being greyish by reflected, and somewhat bluish by transmitted, light. Gelatin is not liquefied. The chief characters of the *B. coli communis* are that it produces fluorescence in neutral red "shake" cultures, acid and gas in lactose broth, indol in peptone-

water, and acid and clot in litmus milk. Such a culture has been termed by Dr. A. C. Houston, a *flaginac* (*fl* = fluorescence, *ag* = acid and gas, *in* = indol, *ac* = acid and clot) colon bacillus.

The **B. Typhosus** is occasionally found in suppurative conditions of bones, which may ensue as sequelæ of typhoid fever. In its growth on agar and gelatin it resembles the *B. coli communis*. It is actively motile, and, like the *B. coli communis*, is Gram-negative. From the *B. coli* it is readily distinguished by the "flaginac" test, since the *B. typhosus* produces no fluorescence in neutral red media, no acid nor gas in lactose broth, no indol in peptone-water, no clot, but only acidity, in litmus milk.

Some Bacteriological Methods of Surgical Diagnosis.

Examination of Pus for Micro-Organisms.—The use of *Leishman's stain* will be found to give very beautiful preparations. The steps in the procedure are as follows: (1) With a platinum loop smear a small bead of pus evenly over the slide; allow to dry. (2) Cover the film with Leishman's stain, which not only stains, but also fixes the film. (3) After one minute add an equal volume of distilled water to the stain, and mix. (4) Continue the staining process for five minutes. (5) Wash with distilled water. (6) Dry with filter-paper and by holding over flame. (7) Add a drop of cedar-wood oil to slide, and examine at once by means of an oil-immersion lens.

In this process the nuclei of the pus cells and the various micro-organisms stain a beautiful violet colour, whilst the protoplasm of the cells stains a faint pink. The same method can be used for staining blood-films, and if the staining process is prolonged, for demonstrating the *Spirochæta pallida*. We have already seen that Gram's method of staining allows of a classification of micro-organisms into two great groups—those which retain the stain in the process (**Gram-positive**), and those which lose it (**Gram-negative**).

The Gram Process of Staining is as follows: (1) Make film by smearing a little of the material evenly over the slide. (2) Fix film by passing it slowly three times through the flame of a Bunsen burner. (3) Stain with carbol-gentian-violet five minutes. (4) Wash with water. (5) Cover film with Gram's iodine solution, and allow this to remain on until the film becomes black; usually one minute is sufficient. (6) Wash with absolute alcohol until the stain ceases to come away. (7) Dry and then stain one-half of the film with a solution of fuchsin. (8) Wash in water. (9) Dry with filter-paper and over flame (10) Clear in xylol. (11) Mount in balsam. If the film is not to be preserved, it is not necessary to carry out (10) and (11), but instead, a drop of cedar-wood oil should be added, and the slide at once examined with an oil-immersion lens.

If the organisms are **Gram-positive,** they will be stained a dark violet colour; if **Gram-negative,** they will be uncoloured on one-half of the film, but will be red coloured on the half which has been treated with fuchsin solution.

Staining Tubercle Bacilli.—The surgeon is most frequently called upon to ascertain whether tubercle bacilli are present in the urine We shall therefore describe the examination of this fluid for their presence; the same procedure can, of course, be applied to other pathological material.

The urine is received into a sterilized bottle and allowed to stand

for some hours. The upper part of the urine is then poured off, and the lower part, including the sediment, is put into clean test-tubes and centrifugalized. The urine is now pipetted or siphoned off from the deposit, and replaced by an equal volume of water, with which the deposit is mixed. Centrifugalization is repeated, and finally the water is removed and a film is made on a slide from the deposit. The further steps are—(1) Fix the film by passing through flame. (2) Stain with carbol-fuchsin three to five minutes. During this time the stain is kept steaming by holding the slide over a Bunsen flame. (3) Wash in water, and decolourize with 30 per cent. nitric acid. (4) Continue decolorization process with absolute alcohol. (5) Counterstain with methylene blue one minute. (6) Wash with water. (7) Dry film. (8) Examine with oil-immersion lens. The tubercle bacillus is stained a bright red colour, and often clumps of bacilli will be found. If other micro-organisms, such as the *B. coli communis*, staphylococci, streptococci, pneumococci, etc., are present, they will be stained blue.

Staining the Spirochæta Pallida.—(1) The chancre is cleansed and pricked at its base, and some of the serous fluid exuding is smeared over a slide. (2) The film is fixed for ten minutes in absolute alcohol. (3) The preparations are then stained for two to twenty-four hours in a dilute solution of **Giemsa's stain.** (4) Washed in distilled water. (5) Dried and mounted.

The dilute Giemsa is prepared by adding one drop of the Giemsa stain to 1 c.c. of water, and rendering alkaline with a few drops of 1 per cent. potassium carbonate solution.

Leishman's Staining also gives good results. The procedure is as follows : Take two glass slides and on one of these spread the material to be examined—usually exudation from the primary chancre or from a condyloma or mucous patch. The other slide should be heated carefully in the Bunsen flame until a slight but perceptible curve is produced. A few drops of Leishman's stain are now poured over the film and allowed to remain for half a minute. Double this quantity of distilled water is now added and mixed thoroughly with the stain, preferably by blowing gently on the surface. The stain is now transferred to the curved slide, which lies with its concavity upwards, and the film brought again into contact with the stain by inverting it over the curved slide, where it is allowed to remain for half an hour. By this means the deposit on the surface of the film of any sediment present in the stain is avoided. After washing with distilled water and drying, the film is examined with the oil-immersion lens. Attention should be directed especially to the immediate neighbourhood of the red blood-cells, since the spirochætes are most frequently found in this position.

In these methods of staining, the *Spirochæta pallida* appears as a faintly stained, slender, pink spirillum

CHAPTER III

HÆMATOLOGY, IMMUNITY, AND VACCINE TREATMENT

The Blood in health and in disease—Enumeration of red corpuscles—Estimation of hæmoglobin—Estimation of the number of leucocytes—Abnormal constituents of the blood—Coagulation time of the blood—Natural and acquired immunity—Theories of immunity—Phagocytosis—Reaction of the body to infection—Agglutinins—Precipitins—Opsonins—Estimation of Opsonic Index—Complement deviation—Vaccine therapy—Generalized infections—Localized infections.

THE BLOOD IN HEALTH AND IN DISEASE.

THE blood, as it circulates in the body, consists of a plasma in which the red and white corpuscles float. After removal from the body it coagulates, so that there results a clot, which contains the corpuscles, and a straw-coloured fluid serum. By examination of the corpuscles, serum, and the clotting power of the blood, changes are found, which are of use in the diagnosis and treatment of disease.

Normal, healthy blood contains in each cubic millimetre about 5½ million red corpuscles. These are flat, biconcave discs, non-nucleated, and containing the colouring matter of the blood—hæmoglobin—evenly distributed within their substance. The number varies slightly even in health, and it is less in women than in men, the former having only about 5 million per cubic millimetre.

In health the amount of hæmoglobin contained in the blood is pretty constant, so that a definite standard can be taken with which to compare the amount present in disease.

The number of white corpuscles is very variable, even in health. It varies at different times of the day and with meals, so that a blood which had 5,000 leucocytes per cubic millimetre before a meal may have 10,000 or even more shortly after the meal. As, however, the changes in disease are usually very gross, these smaller normal variations are of less significance, although they must be kept in mind. The number of leucocytes which are present in a cubic millimetre of healthy blood varies from 5,000 to 10,000, and there is a pretty constant relation of the numbers of the different forms of leucocytes to each other, so that a differential count—that is, a count of each variety of leucocyte separately—is often of great value. It is unnecessary for us to go minutely into the form of the different kinds of leucocytes, as these are fully described in the works on histology; but the relative numbers in which they are normally present are as follows:

	Per Cent.
Polymorphonuclears	72
Lymphocytes	22
Large mononuclears	3
Eosinophiles	3

We shall see later how this relation is disturbed in some diseases.

Enumeration of Red Corpuscles.—In health there are 5 to 5½ million red corpuscles per cubic millimetre in men, and about 4½ to 5 million in women. At high altitudes there is normally a higher count up to 7 million, or even more. In many diseases there is a diminished number down to 1 million or less. This is marked in all the *acute fevers* and in *septic conditions*, especially if long continued. In all *cachectic conditions*, also, there is a reduction in the red corpuscles, and in the *primary anæmias*, such as chlorosis and especially pernicious anæmia, the reduction may be very great.

The estimation is carried out by means of a hæmocytometer, the blood being diluted 100 or 200 times with normal salt solution, and the number of corpuscles in a given area, on the specially ruled slide, counted.

Estimation of the Hæmoglobin.—There are many instruments designed for this purpose, but probably the one most commonly used is Haldane's hæmoglobinometer, in which the blood is diluted in a special calibrated tube, and then coal gas is passed through to convert the oxyhæmoglobin to carboxyhæmoglobin. There is a standard tube, corresponding to the colour of normal blood treated in like manner. The patient's blood is now diluted until the colour is the same as the control tube, and the amount of dilution required determines the amount of hæmoglobin present.

The term **colour index** is used to denote the relation of the number of red corpuscles to the amount of hæmoglobin—*i.e.*, the amount of hæmoglobin per corpuscle. Normal blood is taken as unity, and the colour index is said to be high when the number of corpuscles is reduced in greater proportion than the amount of hæmoglobin; low when the reverse state exists. *A high colour index* is to be found in *pernicious anæmia*, whereas in *chlorosis*, and in many cases of *secondary anæmia*, it is very *low*. In cases of **hæmorrhage,** at first the red corpuscles and the hæmoglobin are diminished in the same proportion, due to the direct loss of blood. Soon, however, the volume of the blood is made up by absorption of the fluid from the tissues. Later the red corpuscles increase in number before the hæmoglobin, so that the colour index drops, then gradually rises, until the normal condition is restored.

Estimation of the Number of Leucocytes.—This is in surgical diseases a much more important observation than the two preceding. The estimation is carried out by means of a hæmocytometer, as in the case of the enumeration of the reds, but instead of diluting the blood 100 or 200 times, it is only diluted 10 or 20 times with 1 per cent. acetic acid. A small drop is then transferred to the measured slide, and the number of corpuscles counted in several of the large squares. At least 400 cells should be counted to eliminate errors due to unequal distribution. For a *differential count* the diluting fluid has added to it a small quantity of gentian violet, which stains the nuclei of the leucocytes, and makes the recognition of the variety of leucocyte easy. An increase in the number of the leucocytes is rarely a uniform increase of all the varieties, but more commonly affects only one or two of these, and according to which variety is increased, so different terms are employed. *Polynuclear leucocytosis* and *lymphocytosis* denote an increase in the number of these varieties, while *eosinophilia* is the term employed when there is an increase in the eosinophile constituents.

Polynuclear Leucocytosis.—This may be divided as follows :

1. **Physiological**—(*a*) *Digestion.*—There may be a rise up to 12,000 per cubic millimetre within a few hours of a meal.

(*b*) *Pregnancy.*—The count may be 15,000 in the last months of pregnancy.

(*c*) *New-Born.*—At birth the count may be twice normal. It then falls rapidly, but rises again to a lesser extent.

2. **Pathological**—(*a*) Over 100,000 : Leukæmia.

(*b*) 20,000 to 100,000 : Pneumonia ; following severe hæmorrhage ; some infectious diseases, as scarlet fever, diphtheria, meningitis, etc. ; suppuration.

(*c*) 10,000 to 20,000 : Lesser degrees in inflammation and suppuration ; perforation in typhoid fever ; malignant tumours.

In surgery it is very marked in those cases where there is **locked up pus,** and its diagnotic significance is considerable when in, say, the case of an appendix abscess which has been opened, there is, after a few days, a rapid increase in the number of leucocytes, thus pointing to the accumulation of pus, probably in the shape of a subphrenic abscess. In such a case the numbers of leucocytes may rise in a few hours from 10,000 or 15,000 to 30,000 or 40,000 per cubic millimetre.

Eosinophilia.—This is especially to be seen in diseases caused by animal parasites, such as *Trichina spiralis*, *Bilharzia hæmatobia*, round-worm, or hydatid disease. It is also found in asthma, and in some skin diseases—*e.g.*, pemphigus.

Lymphocytosis.—The most striking instance of this occurs in *lymphatic leukæmia*, where the numbers may be as high as 200,000 per cubic millimetre. In general tuberculosis, in influenza, and in malaria, there may be some slight lymphocytosis, but it is never very marked in these conditions, and a blood-count is rarely of significance in these diseases except by establishing the fact that other infections may be excluded by the absence of a polynuclear leucocytosis.

Leucopenia—*i.e.*, a diminution in the number of leucocytes—is found in typhoid fever, malaria, and sometimes in general tuberculosis. The decrease is usually chiefly in the number of polynuclear corpuscles.

Abnormal Constituents of the Blood.—For a complete account of these, a special work must be consulted. They may be classed as follows :

Abnormal Red Corpuscles.—*Normoblasts*, small nucleated corpuscles with a deeply staining nucleus and a small amount of protoplasm, staining red with eosin.

Megaloblasts, large nucleated red corpuscles.

Poikilocytes, misshapen non-nucleated red corpuscles ; usually pear-shaped.

All these are best seen in pernicious anæmia.

Abnormal White Corpuscles.—*Myelocytes*, incompletely developed leucocytes with neutrophile or eosinophile granules.

The Coagulation Time of the Blood.—This is estimated by taking four or five capillary tubes of approximately the same calibre and about 6 inches long. These are held together in a bundle, and the patient's finger having been pricked, blood is allowed to run up these tubes simultaneously (by capillary attraction). The ends of the tubes distal to the blood are now rapidly sealed in a flame, and the tubes are dropped into a vessel of water at a temperature of 37° C. In one and a half minutes a tube is taken out of the water, the sealed end is

broken off, and the contents are blown out on to a piece of filter-paper so that it can easily be seen if a clot has formed. This is repeated with another tube half a minute later, and so on till it is found that a clot has appeared. The result having been obtained to within half a minute, greater accuracy can be obtained by taking another two tubes and collecting blood in them in a similar manner, leaving them in the water-bath for twenty and ten seconds less than the time at which the blood was found to clot in the previous observation. A result is thus obtained within ten seconds of the true coagulation time.

The *normal coagulation time* under these conditions is one minute fifty seconds, but apparently quite normal persons vary from one minute forty seconds to two minutes.

The coagulation time is *lengthened* in cases of *hæmophilia*, where it may be as long as twelve minutes, in cases of *urticaria* and *chilblains*, and in many conditions where there is a *tendency to hæmorrhage*. The time is *shorter* than normal in many *acute diseases*, especially where the patient has been fed largely on milk, which has the effect of increasing the coagulation power of the blood. *Citric acid*, and all fruits and drinks which contain this or one of the allied acids, increase the coagulation time, presumably by neutralizing the calcium of the blood, which is essential to clotting. On the other hand, the administration of *calcium*, either in the form of the chloride, the lactate, or milk, shortens the time.

In performing the test great care must be taken that the blood should have no admixture of lymph from the tissues of the finger. This lymph greatly accelerates the clotting power of the blood, and where the finger has been vigorously compressed to obtain the blood the coagulation time of the blood so obtained may be as short as thirty seconds, whereas the real coagulation time of the blood properly drawn is over two minutes.

IMMUNITY.

Immunity may be of two kinds—natural or acquired.

Natural Immunity *is the power of a species of animal to resist an infection to which other species are susceptible.* Thus all the lower animals are immune to the gonococcus, and most of them cannot be infected with syphilis, to both of which infections man is very susceptible. On the other hand, man is immune to many of the diseases of the lower animals, such as distemper of dogs, rinderpest, etc. Sometimes this immunity bears close relation to the zoological position of the species, as is seen in the fact that of all animals the higher apes are the least immune to syphilis ; but there are numerous exceptions to this, and goats, although closely related to cattle in the zoological scale, are relatively immune to tuberculosis, to which cattle are susceptible.

Acquired Immunity may be of two kinds—*active* or *passive*—depending on the way in which the immunizing process is brought about. **Active immunity** to a disease is brought about by the individual having had an attack of that disease, or, what is really the same thing, having had administered some of the bacterial poisons in the shape of a vaccine. It is *active* because the individual himself has to produce the immunizing substances in contradistinction to the case where an animal is actively immunized by the injection of a vaccine,

and some of its immune serum is injected into another individual, so that this second individual merely plays a *passive* part in the process.

Theories of Immunity.—Many theories have been put forward to explain the phenomena met with in the study of immunity to bacterial disease. The *humoral theory*, elaborated in detail by Ehrlich, and the *cellular theory*, put forward by Metchnikoff, are the only two we need concern ourselves with here. According to the humoral theory, the immune substances are contained in the body fluids, while the upholders of the cellular theory maintain that the changes occur in the cells, and that any substances in the serum destructive to bacteria are merely products of the cell enzymes.

Ehrlich's Theory.—Ehrlich has compared the cells of the body to a complex organic substance, consisting of a central stable combination, and having attached to it a number of molecules in loose combination. He compared it with a benzene compound, where there is a central benzene ring, and attached to this ring there may be many molecules, which are easily altered to form new compounds. These side chains, or *receptors*, are the parts of the cell to which the toxins become united, and so obtain access to the cell. The combination of the toxin and the cell (receptor) has been compared with the fitting of a key in a lock, so that the toxin must have a receptor which fits it, else there is no combination. Thus, one way in which an animal may be immune to infection is that the toxins of this infecting organism do not fit any receptors of the cell, so that they have no action on that cell.

When large doses of toxin are injected, sufficient becomes united to the cell to kill it; but if small doses are injected, only some of the receptors become joined to toxin molecules, and then the cell takes on the function of regenerating these receptors; but, as is common in nature, regeneration is far in excess of destruction, so that many more receptors are produced than are wanted by the cell. These receptors are thrown off by the cell into the blood-fluids, and are capable of combining with and neutralizing further doses of toxin before they reach the cells, thus constituting a defence for the cells against the particular toxin, and consequently rendering the individual immune to that toxin.

Ehrlich's theory can be applied not only to immunity, but also to the normal physiological processes connected with the absorption of nutriment into the body. The foodstuffs, after being absorbed from the alimentary tract, become joined on to the cell body by means of suitable receptors, and bodies for which there are no receptors are thus useless for nutrition.

Phagocytosis.—Metchnikoff, by a brilliant series of researches, established that in all stages of animal development, the body was able to rid itself of foreign bodies and parasites by means of engulfing them and digesting them inside the cell. To this process of ingestion the name "phagocytosis" has been given. Metchnikoff thought that this was a phenomenon which depended entirely on the cell, and in which the blood-fluids had no part, so that where there was an increased phagocytosis, he maintained that it was due to increased activity of the cells. More recently, however, Wright and Douglas have shown that the part played by the blood-fluids in the process of phagocytosis is a most important one, and **that in the absence of serum the leucocytes are quite incapable of taking up "raw" bacteria, although they show a powerful phagocytic action on bacteria which have previously been subjected to the action of fresh serum.** Thus it will be seen that there are two influences in the process of phagocytosis—the

leucocyte and the substance in the serum which renders the bacterium fit for consumption by the leucocyte. To this latter substance the name **opsonin** has been given.

The degree to which bacteria are susceptible to phagocytosis varies enormously in the different species. Most of the common bacteria, under suitable conditions, have the power of attracting leucocytes towards them, so that where there is an infection with such a bacterium, there is an infiltration of leucocytes around the focus of infection. Such organisms are spoken of as **positively chemiotactic.** There are others, however, which have no such attraction to the leucocytes, but which may even have a repellent influence, although this active repulsion has never been definitely established. These are spoken of as **negatively chemiotactic.**

FIG. 1.—PHAGOCYTOSIS OF COCCI AND BACILLI IN PUS FROM AN INFECTED WOUND.

Reaction of the Body to Infection.

When a highly complicated organic body, such as serum, blood-corpuscles, bacteria, or the like, is injected into an animal, there results the production of certain **antibodies** which are **specific to the particular body injected,** so that when these antibodies can be recognized, they furnish proofs of the nature of the infection. A substance which, when injected, will give rise to the production of antibodies is termed an **antigen,** and if any particular antibody is found in the serum, then we can assume that that individual has had an infection (or an artificial inoculation) with a particular antigen. The antibodies which may be formed are of various kinds, but for purposes of clinical work the following are the most important :

1. Agglutinins
2. Precipitins.
3. Opsonins.
4. "Immune bodies," bactericidal, hæmolytic, etc.

Agglutinins.—These are substances in the serum of an infected or immunized patient, which, when mixed with the infecting bacteria,

cause them to run together into masses. Agglutinins are stable bodies, not being destroyed by heating to 60° C., and retaining their activity in serum for many months. The most common application of this reaction is the **Widal test for typhoid,** but it is used also in the diagnosis of dysentery (bacillary), Malta fever, glanders, and infections by *B. coli*, *B. paratyphosus*, and the allied organisms from the intestinal tract.

The test is done as follows : A wide capillary tube is taken, and a mark is made about ½ inch from the end. With a rubber teat a number of equal volumes of normal salt solution are drawn up into the tube by drawing the fluid up to the mark, then drawing up a small air-bubble, then a second volume of fluid, and so on, till six volumes of fluid have been taken up ; they are then expelled separately on to a microscope slide, so as to form six small drops. To the first is added an equal volume of serum from the blood-capsule : an even mixture is obtained by drawing it up and down the capillary once or twice. Then one volume of the mixture is transferred to the next drop on the slide ; this is, in turn, mixed, and one volume carried on to the next drop, and so on. The last drop receives no serum, and is used as a control. One has by this procedure dilutions of serum of 1 in 2, 4, 8, 16, and 32. Six similar volumes of an emulsion of a fresh culture of typhoid bacilli are now taken up in the pipette, and one volume is added to each of the dilutions of serum and mixed with it. The control drop also receives a volume of typhoid emulsion ; finally, there results, therefore, dilutions of serum of 1 in 4, 8, 16, 32, and 64. One volume of each of these is taken up in the capillary tube (small volumes of air being taken up to separate the different dilutions), the end of the tube is sealed off in a flame, and the tube is incubated for half an hour at 37° C. If at the end of this time there is agglutination visible to the naked eye in the 1 in 32 dilution, the reaction is positive, and indicates a typhoid infection. (Always provided the patient has had no inoculations of typhoid vaccine, or has not suffered from typhoid fever previously.) For the other organisms the test is done in exactly the same way, with the exception that, instead of typhoid emulsion, there is added an emulsion of the organism which is suspected.

Precipitins are substances in the serum of an immunized animal which are capable of causing a precipitate when they are mixed with a clear solution of the antigen. This precipitation is readily seen when the serum of an animal immunized against cholera, typhoid, etc., is mixed with a clear filtrate of a broth culture of the particular organism against which the animal has been immunized. The most common application for these bodies in medicine is in the **biological test for human blood.** In this the serum of an animal immunized against human serum is mixed with a saline extract of the blood-stain in question. If a precipitate forms, then this stain is either from human blood or from one of the higher apes, and is certainly not from one of the lower animals. Precipitins can be obtained by injecting animals with almost any foreign albuminous matter, such as blood-serum, egg albumin, milk, etc.

The precipitins in serum are not destroyed at temperatures under 65° C., and persist on keeping for a considerable time.

Opsonins.—These are substances in the serum which act on the bacteria in such a way that they are rendered palatable to the leucocytes, and so are capable of being taken up (phagocyted).

Properties.—In normal serum all the opsonic substance is *thermo-*

labile—that is, capable of being destroyed by heating to 60° C. for ten minutes. In many of the serums from infected persons some of the opsonic substance, on the other hand, is *thermostable*, and this has been used as a means of diagnosis. Opsonin is not destroyed by desiccation.

The **opsonic index** is the ratio of the amount of phagocytosis obtained when the patient's serum is used to that when a normal serum is used, the other factors in the estimation being the same in each case.

Technique of the Estimation of the Opsonic Index.—Three things are required :

1. Washed human corpuscles.
2. Emulsion of bacteria.
3. Serum, patient's, and normal.

The *Washed Corpuscles* are made by bleeding from the finger into 1½ per cent. citrate of soda (to prevent coagulation), and centrifuging till the corpuscles are separated ; then the supernatant solution is removed and replaced with normal salt solution, shaken up, and again centrifuged. Again the supernatant fluid is removed and the corpuscles are ready.

Bacterial Emulsions are made by breaking up in normal salt solution a small quantity of a young culture of a bacterium required. (With tubercle, a small quantity of dead tubercle bacilli are ground up in 1 per cent. salt solution, and the suspension so made is centrifuged to remove the clumps of bacteria and leave an even emulsion for use.) The most important part in the estimation as regards the accuracy of the results is the obtaining of an emulsion which is practically free from clumps of bacteria.

Serum is obtained with an ordinary blood-capsule by pricking the finger.

The estimation is done in small capillary pipettes. A mark is made about ½ inch from the end of the pipette with an aniline pencil ; one volume of corpuscles is taken up, then an air-bubble, then one volume of bacterial emulsion, another air-bubble, and finally one volume of patient's serum. These are mixed by blowing out on a slide four or five times.

The mixture is lastly drawn about halfway up the tube, the end of which is sealed in the flame, and the tube is placed in the incubator at 37° C. A similar mixture is now made, except that normal serum is used instead of patient's. At the end of fifteen minutes the tubes are taken out, and films are made of the contents of each. These films are stained, with carbol fuchsin in the case of tubercle, and with carbol thionin for other organisms, and the numbers of bacteria which are taken up by the first hundred leucocytes met with are enumerated in each.

The opsonic index is—

$$\frac{\text{Number taken up using the patient's serum.}}{\text{Number taken up using normal serum.}}$$

Thus, if in the former case there were 150 bacteria in 100 cells, and in the latter 100 in the same number, the opsonic index would be $\frac{150}{100} = 1{\cdot}50$.

The advantage of the opsonic index over agglutination is that it is applicable to practically all organisms, whereas, with the commonest

infecting agents, such as the staphylococcus, there is usually no agglutinin developed.

The opsonic index may be used either for diagnosis or for the control of vaccine treatment. Its use for the latter purpose will be dealt with later ; for diagnosis it may be used in several ways.

1. A single estimation may be made. This is the least useful method, as in many infections the index fluctuates considerably, so that it is quite likely that at the time the blood is drawn the index may be normal, although at another time of the day it will vary widely from normal.

2. Specimens are taken at different times of the day, say, morning and evening, so that such fluctuations are noted. A fluctuating index indicates active infection by the organism to which the blood is tested.

3. Specimens are taken before, and again three and six hours after exercise, massage, or some such disturbance of the infected part. Thus, if a knee-joint is infected, and it is wished to diagnose if it is tuberculous, the joint is exercised, massaged, or a Bier's bandage is put on above it for one hour. The blood is taken before this is commenced, and again two and four hours after, and if the joint is tuberculous, the index will fluctuate in the same way as if a small inoculation of tuberculin had been given. The explanation is that a small quantity of tuberculous material has actually been transferred from the joint to the blood, and so has evoked the production of antibodies. This process is called **artificial auto-inoculation,** and it is the only method by which the exact nature of a local infection can be accurately diagnosed by means of serum tests alone. Thus, agglutination reactions or opsonic indices, taken singly, may show that the patient is suffering from a certain infection somewhere, but they do not in any way localize it; whereas by observing the effect of auto-inoculation from the focus of infection on the opsonic index, one can diagnose that such a focus is or is not tuberculous, even when the patient is certainly suffering from tubercle elsewhere.

Complement Fixation.—As this test in practice is applied almost exclusively to syphilis, the subject is dealt with in the chapter on that disease (p. 732).

VACCINE THERAPY.

A vaccine is an organic substance which, when injected into the body, will give rise to the production of antibodies protective against the substance injected. This wide definition makes a vaccine identical with an antigen ; but, so far as it concerns practical vaccine therapy, it is **a standardized suspension of micro-organisms in normal salt solution.**

Vaccines are called " autogenous " or " stock " according to whether or not they are made from cultures of organisms derived directly from the patient to be injected. An autogenous vaccine is one made from the patient's own organisms, while a stock vaccine is made by mixing many strains of the same organism obtained from many patients. In both cases the vaccine should be made from freshly isolated cultures. Usually autogenous vaccines will give the best results, but in many cases, and especially in infections with the common pyogenic bacteria, stock vaccines are little inferior to autogenous ones. Sometimes also

when the patient is acutely ill, as in puerperal septicæmia, time would be lost in waiting for a vaccine to be made, so that, to begin with at least, a stock vaccine must be used.

Preparation of the Vaccine.—The organism is grown on a suitable culture medium, and then washed off the surface of the medium with sterile salt solution. The tube containing the suspension of bacteria is then sealed off and violently shaken so as to break up the clumps or chains of bacteria into their single elements, thus enabling their enumeration to be carried out with some accuracy. To count the number of organisms in the vaccine one takes up in a capillary pipette equal quantities of the vaccine and one's own blood, mixes them thoroughly, and makes a film, which is stained in the usual way for blood-films. The numbers of red corpuscles and of bacteria are now counted in twenty fields of the microscope, and as within very narrow limits one knows the number of red corpuscles in one's own blood, the number of bacteria are easily calculated. For instance, if one finds that there are in the twenty fields 400 red corpuscles and 200 bacteria, one knows that there are in 1 cubic millimetre 5 million red corpuscles, so that there would be in the same volume 2½ million bacteria or 2,500 millions in 1 c.c.

The vaccine is now heated to kill the bacteria, but too strong heat must not be used else it destroys the active properties of the vaccine. With different vaccines the temperature at which sterilization is carried out varies slightly, but in most cases 60° C. for three-quarters of an hour is sufficient. After the vaccine is sterilized, a few drops should be expelled from the tube on to the surface of an agar slope, and incubated for twenty-four hours, to make sure that the sterilization has been efficient. The vaccine is now diluted down with sterile salt solution to a suitable strength for use, and, as an additional safeguard against contamination, carbolic acid should be added up to a strength of ½ per cent.

Sensitized Vaccines.—In these vaccines the organisms are submitted to the action of an excess of an immune serum (serum of an animal which has been immunized by injections of the particular bacteria in question). The "sensitized" organisms are then separated from the excess of serum by centrifugalization, and are suspended in salt solution in a convenient dilution. Besredka, who introduced this modification, does not kill the bacteria, but in England it is usual to add carbolic acid up to ½ per cent. It is claimed for these vaccines that much larger doses can be given without inducing a "negative phase," and that the immunity reaction is more prompt, but up to the present the clinical results seem to be no better than can be obtained with ordinary vaccines.

Changes observed following the Administration of Vaccine.—When a vaccine is injected, changes take place in the body, which sometimes can be noted clinically, sometimes only by means of blood-tests. If a subminimal dose is used, then no appreciable change results. A rather larger dose will cause a rise in the opsonic index which will last only for a short time. A larger dose still will cause at first a small drop in the index (**the negative phase**), which will pass off in twenty-four hours, and then the index will rise (**positive phase**), and the rise will be maintained for a period of a week or more. If the dose given is much too large, then the index will go down, and the subsequent rise will not take place, so that by overdosing the patient much harm can be done. The charts which follow show the effect of varying doses on the index.

When an effective dose of vaccine has been given to a patient who has a slight temperature, the temperature will be found to be lower for a day or two following the injection. If, however, the dose of vaccine is too large, the temperature will go up for a time, varying with the size of the dose, and the patient will suffer from general malaise, while the focus of infection will as a rule show increased pain and tenderness.

All the changes which follow the injection of a vaccine also follow the absorption of poisons from the patient's own focus of infection. This **auto-inoculation** can be induced by any procedure which disturbs the infected part, such as operation, exercise, massage, active or passive hyperæmia, etc., and the same changes are to be observed both clinically and by blood-tests as those which follow an injection of vaccine.

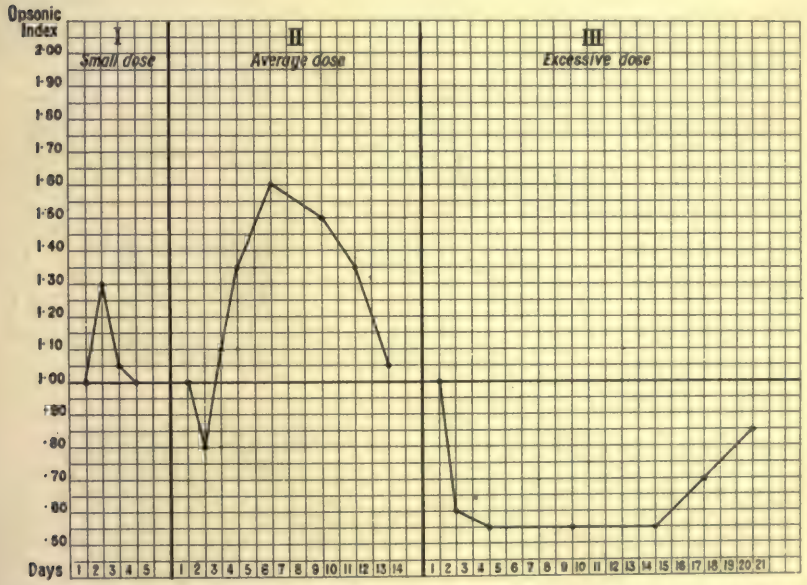


CHART I.—SHOWING THE EFFECT OF VERY SMALL, MEDIUM, AND LARGE DOSES OF VACCINE ON THE OPSONIC INDEX.

The methods of treatment of bacterial infections may be classified thus :

1. Removal of the focus of infection by surgical means where such a focus is accessible.
2. Treatment with antiseptics locally.
3. Supporting the strength of the patient, and combating unpleasant symptoms by dietetic and therapeutic measures. This, while it has no direct harmful effect on the bacteria, must be employed in most cases, even where more energetic and direct means are taken to eradicate the infection.
4. Exhibition of certain drugs which seem to have a specific inhibitory action on the infecting organism. This especially refers to the action of mercury and Salvarsan in syphilis, quinine in malaria, and some of the arsenical preparations in trypanosomiasis.

5. Methods for the determination of blood and lymph to the infected focus : (*a*) *General :* Measures diminishing the viscosity of the

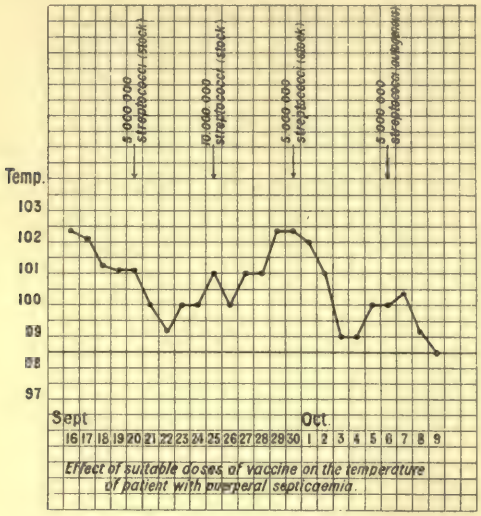


CHART II.—SHOWING THE EFFECT OF SUITABLE DOSAGE OF VACCINE ON THE TEMPERATURE.

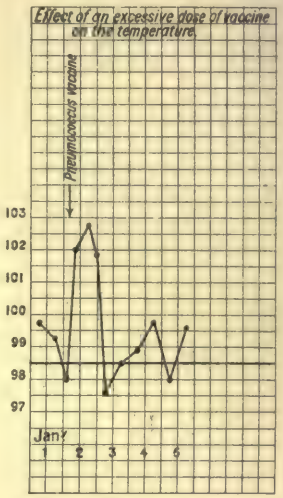


CHART III.—SHOWING THE EFFECT OF AN EXCESSIVE DOSE OF VACCINE ON THE TEMPERATURE.

blood, such as citric acid. (*b*) *Local :* All conditions causing active or passive hyperæmia, including poultices, fomentations, Bier's active

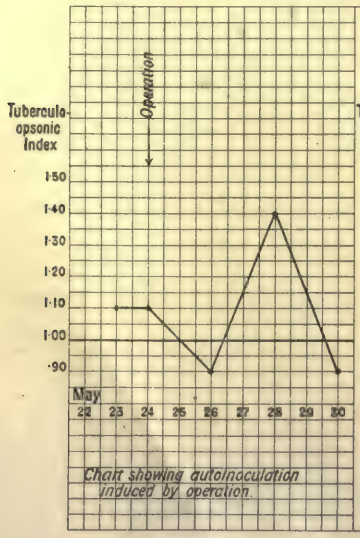


CHART IV.

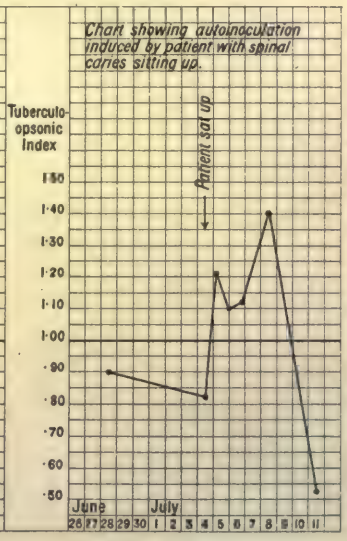


CHART V.

and passive hyperæmia, application of Finsen light and X rays, massage, strong saline solutions locally applied, etc.

6. Specific immunizatory methods : (*a*) Serum therapy. (*b*) Vaccine therapy.

With the first four methods of treatment we have nothing to say in this chapter, but the fifth method is so intimately bound up with vaccine therapy that some allusion to it must be made here. In the centre of any focus of infection there is a part where the circulation is either very sluggish or where it is absent. In this part the bacteria flourish, unchecked by the antibacterial substances of the blood, so it is essential to the success of treatment by a vaccine that one should be able not only to increase the protective power of the blood, but that one should devise some means of bringing the blood to the infected spot.

In many bacterial diseases the coagulation time of the blood is very short, and to counteract this, citric acid should be administered in large doses (½ to 1 drachm) three times a day. Local measures for determining the blood to the infected part are poultices, fomentations, Bier's active and passive congestion methods, which are described elsewhere, massage, etc. But there is one method which Sir Almroth Wright has used very largely in conjunction with vaccines where there is an open wound, such as a sinus or ulcer ; this is the local application of a solution of common salt (5 per cent.), and citrate of soda (½ per cent.). The salt solution, being strongly hypertonic, attracts fluid from the tissues, while the citrate by its decalcifying action prevents the clotting of such fluid and so prevents the formation of scabs. The fact that in the centre of a focus of infection there is an area of low " bacteriotropic pressure," where the bacteria flourish unchecked, is the basis for the surgical treatment of these conditions, and the old dictum, " When there is pus, let it out," applies whether or no vaccines are employed.

Generalized Infections.

When infection takes place in the blood-stream, in most cases the organisms are taken up by the leucocytes and so destroyed ; but if the amount of the infection is very large, or if the organism is a very virulent one, or if the resistance of the patient is very low, then some of these organisms may escape and lodge themselves in some part of the body where they, by some means or other, not properly understood, become protected against the antibacterial substances in the blood. From these small foci organisms are being poured out into the blood-stream, as in cases of *septicæmia,* or, in addition to this, the bacteria which lodge in the tissues may cause an aggregation of leucocytes, and so form local abscesses, as in *pyæmia.* This latter is more favourable in general than is a case of septicæmia, as the aggregation of leucocytes shows that the body is capable of offering some resistance to the infection, and the additional resistance, which is induced by a vaccine, is more likely to turn the scale.

Cases of generalized septicæmia of almost every kind have been treated with vaccines. The success following their administration has been variable. In some cases where the infection has been a very severe one, as in certain cases of puerperal septicæmia, death has taken place before a vaccine could be made. In other cases the vaccine has had almost no effect, and the case has progressed to a fatal end, just as it would have done without the vaccine. In others, however, the administration of the appropriate vaccine has brought about a very

remarkable improvement, each dose of vaccine being followed by a reduction in the fever coincident with a rise in the opsonic index.

Chart II. shows the temperature chart of a case of puerperal fever, treated with a vaccine made from streptococci isolated from the blood, and there is to be seen a decided drop in the temperature following each dose.

Treatment of a case of septicæmia by a vaccine might, on the face of it, seem absurd, as there are already far too many bacterial products in the circulation. The explanations which have been offered to account for the improvement which may follow the administration, when there has been little or no natural response to the infection, are—

1. That the bacteria circulating in the blood do not come into intimate contact with those tissues which have the property of forming the antibacterial substances.

2. That the circulating bacteria do not come into contact with such tissues in sufficient concentration to produce an immunizing response.

In such cases, as in all other infections, vaccine treatment should be combined with such surgical measures as are required. In connection with a case of acute general infection the procedure to be adopted should be as follows :

Ten or twenty cubic centimetres of blood are drawn off with a sterile syringe from a vein, preferably one at the bend of the elbow. The blood is best drawn off when the patient's temperature is high, as it is then that a growth of the organisms is most readily obtained One cubic centimetre of this blood is then expressed into each of several broth or glucose broth tubes, which are incubated and examined at intervals to see whether there is any growth. In some cases growth is slow, so the tubes must not be rejected as sterile for several days. In many cases, where one is dealing with streptococci, one can easily see when there is growth in the tubes by the fact that hæmolysis occurs. When growth is noted, the organism must be identified by the methods described in the chapter on bacteriology. In all cases a growth of *Staphylococcus albus* must be looked on with grave suspicion, as this is an organism which is only rarely the cause of a septicæmia, but which is the most common contamination of blood-cultures. When growth is obtained, subcultures are made on tubes of solid medium, and a vaccine made in the way described above. The dosage will vary with the organism, and will be alluded to later, but it must be emphasized that in all these cases of generalized infection, **the doses employed must be very small,** and the interval between the doses short. Thus in many cases ½ million of streptococci will be sufficient every twenty-four or forty-eight hours instead of the doses of 5, 10, or 20 millions, which are used in the less severe infections at longer intervals.

The most common of all organisms in these generalized infections is the *streptococcus*, but almost all the common pathogenic organisms have been found in the blood, such as the *staphylococcus*, *pneumococcus*, *gonococcus*, *B. coli*, *B. typhosus*, *B. influenzæ*, *Micrococcus tetragenus*, etc.

Where it is possible, the inoculations should be controlled by means of blood-tests, of which the opsonic index is by far the most useful. In these general infections the opsonic index before treatment is generally consistently low, and if, after one or two inoculations of the appropriate vaccine, one can succeed in raising the index above

normal, the prognosis is in general good. In some cases, which steadily progressed to the grave, it was found impossible to raise the index, no matter what the dose employed, or the interval between doses.

Localized Infections.

It will be convenient to group these according to the region involved, except in the case of tubercular infections, which will be taken separately.

Infections of the Skin and the Subcutaneous Tissues.—As regards surgical diseases of the skin, there are three organisms which are responsible for nearly all the infections. They are *staphylococcus*, *streptococcus*, and the *tubercle bacillus*.

Staphylococcus is to be found pure in almost all cases of boils, carbuncles, sycosis, the deeper whitlows, acute mammary abscess, and some of the forms of impetigo. In ulcers and infected wounds it may be pure, or it may be mixed with streptococcus or other organism, or it may be absent altogether. *Staphylococcus albus* is the most common saprophyte to be found on the skin, so that this organism is found in almost all open infections, whether the original infection is a staphylococcal one or not ; thus the mere presence of this microbe is not sufficient to warrant a diagnosis of infection. Most of the acute staphylococcal infections of the skin are caused by the aureus variety, and a vaccine of this will prove efficacious in all such cases. In many cases some surgical treatment will be necessary to **evacuate the pus,** which will have formed before the case comes under observation, and in all cases where there is an open wound the **hypertonic salt and citrate lotion** will be found of great benefit. The doses of **staphylococcus vaccine** to be employed are from 50 to 500 or 1,000 millions. In general it will be found best to give doses of 50 to 100 millions to the more acute cases, such as carbuncles, whitlows, or mammary abscesses, repeating the same or a slightly larger dose every three or four days. We sometimes find, however, that larger doses, such as 250 millions, greatly hasten the separation of the slough and, consequently, the healing of the infection. The more chronic staphylococcic infections are best treated with 250 to 1,000 millions at weekly intervals. These doses, as all the doses here, are only approximate, and are the average doses used in patients in whom the doses are controlled by clinical appearances and blood-tests. With all these vaccines, however, one finds that some people are very sensitive, while others are not susceptible to even large doses.

Among the less purely surgical skin infections where staphylococcus vaccine is of use, may be mentioned acne vulgaris, where it is very effective in combination with 4 to 8 millions of the acne bacillus. In many cases also of pruritus ani doses of 250 millions relieved the itching where local treatment was of no avail.

Streptococcus is found as a pure infection in erysipelas and most cases of cellulitis ; it is the primary infection in many ulcers and infected wounds, in impetigo contagiosa, in subcuticular whitlows, in paronychia, and in most of the sores due to pediculosis and scabies, and in the secondary abscesses associated with these. In most of the cases in this latter group, however, there is a secondary invasion of staphylococci, so that unless the culture is made in the very early stage, a mixture of staphylococci and streptococci results. Streptococcal infections, as a rule, cause a considerable amount of exudation of

serum, so that if the infection is a closed one a vesicle results, while if the infection is open there is much scabbing. This feature is very constant, so that the clinical appearance furnishes a fairly good guide to the nature of the infection in these cases.

In erysipelas the infective material for cultivation should be obtained by scarifying the raised margin of the infected area ; while in cellulitis, if there is no primary focus accessible cultures can be obtained by injecting a little sterile broth or salt solution (about 3 or 4 cubic millimetres) just beneath the skin, and withdrawing it again into the syringe, from which it is expressed into the culture-tube.

Generally the infection will be found to be of the long-chained *Streptococcus pyogenes*, but sometimes, and especially is this the case in infections of the fingers, a short-chained streptococcus is the infecting agent, probably derived from one or other end of the alimentary tract.

The average dose of streptococcus vaccine is from 2½ to 10 millions, but in very acute cases it would be well to begin with 1 million, and repeat the same or a larger dose in two or three days, according to the result obtained with the first. In an acute case, if the blood is not being tested, one should look for a drop in the temperature or an improvement in the condition if the right dose has been given. Any rise of temperature or exacerbation of the symptoms closely following the dose indicates an overdose, and the next dose should be very much smaller. This applies equally to all vaccines, but the results of the vaccine on the temperature, both for good and evil, are very well seen when working with streptococcus.

Where the infection is a mixed one, a mixed vaccine may be given, and this is especially useful where there is an open tuberculous lesion infected with staphylococcus or streptococcus. In such cases the tuberculin should be combined with the appropriate vaccine of the pyogenic coccus.

Many other organisms, such as diphtheroids, the acne bacillus, anthrax, actinomycosis, etc., may be found in skin infections, but they are relatively uncommon, and need not be considered in detail.

Infections of the Mouth.—The surgical infections which have been treated with vaccines are chiefly **pyorrhœa alveolaris** and **stomatitis.** In both these cases the infection is in by far the majority of cases a *streptococcal* one, although other organisms, such as *staphylococcus*, *pneumococcus*, *Micrococcus catarrhalis*, and others, are sometimes met with. In the mouth the diagnosis of the infective agent is much more difficult than in skin infections, as even a clean healthy mouth has a large number of species of microbes leading a saprophytic existence. The usual way of diagnosing the infecting agent is by making cultures from the infected part after carefully cleansing the surface with sterile salt solution, so as to remove as far as possible the normal inhabitants of the mouth. The various organisms which grow are now isolated, and a vaccine is made either of the dominant organism, or, better, of the organism to which the patient's blood shows an abnormal opsonic index. The infecting streptococcus may either be of the long-chained or the short-chained variety. In general the doses of streptococci in diseases of the mouth are rather high, from 5 to 30 millions, at intervals of one week.

In the case of pyorrhœa alveolaris, treatment by vaccines should always, where possible, be combined with the ordinary dental treatment.

Infections of the Nose, Ear, and Throat.—*Streptococcus* still remains in these regions the chief offender, but the other organisms met with in the respiratory tract become of increasing importance. The most important of these is the *pneumococcus*, less important are the *M. catarrhalis*, *B. influenzæ*, *B. Friedlander*, *B. septus*, and the *staphylococcus*.

Acute catarrh of the nose—in other words, **the common cold**—is almost always caused by one of the following: *Pneumococcus*, *B. septus*, *M. catarrhalis*, and perhaps *M. Paratetragenus*, *B. influenzæ*, and *B. Friedlander*. Treatment by an appropriate vaccine cuts short the cold, and if a dose of vaccine be injected in the very early stage before the coryza has become well established, the attack is frequently aborted. In many cases where it is not practicable to examine the secretion to find out which is the infecting microbe, very satisfactory results can be obtained by using a vaccine of all the organisms named above, mixed in the proper proportions. In some cases the diagnosis of the bacterium can be made with fair certainty by the knowledge that at that particular time there is an epidemic of colds caused by a certain microbe.

The average doses of the vaccines which are used for colds are these:

Pneumococcus	10,000,000
M. catarrhalis	10,000,000
B. septus	20,000,000
B. influenzæ	10,000,000
B. Friedlander	10,000,000

If necessary, the dose should be repeated in two or three days.

In **chronic infections of the nose** and the accessory sinuses the same organisms are found, but here streptococcus and *B. Friedlander* are more prominent. Where there is no necrosis of bone the results with vaccines are good, but of course if there is necrosis or a polypoid condition, then vaccines without active surgical treatment are of little avail. Probably the best results in chronic nasal infections are obtained when the infection is by the influenza bacillus (by no means rare). In such cases, even where the infection has been present for years, it clears up in a few weeks with doses of 5 to 15 millions every five or six days. In cases where the sinuses are infected there is often difficulty in obtaining drainage, and in all such cases efficient drainage must be obtained for a satisfactory result to ensue from any form of treatment.

Infections of the ear are very similar to those of the nose. **Acute mastoiditis** is, as a rule, streptococcal, and here vaccines are very useful combined with operation. The use of the vaccine certainly favours the healing of the wound, and especially helps to ward off certain dangerous complications which may arise. Thus, in one case following the operation for acute mastoiditis, the patient, a child of about twelve, continued to be very ill, and after three days grave doubts were entertained of his recovery. The temperature had continued about 103° F. since the operation. Streptococci were found in the wound, and a dose of 2½ millions of a stock vaccine was given without waiting to make a special vaccine from his own organism. The temperature went down in about twelve hours, and did not rise again, and in a comparatively short time the boy was quite well. In the **external auditory meatus** the principal condition which calls for a vaccine is furunculosis, which is always due to staphylococcus, and which can

well be treated with a stock vaccine in just the same way as furunculosis of the skin alluded to above.

Infections of the Alimentary Tract.—In **gastric affections** vaccines have so far only had a limited use. Bertrand Dawson has recently used them in some cases of gastritis and indigestion, with very good results. The organisms commonly found were a *streptococcus* and the *B. acidi lactici* (a member of the *B. coli* group). The doses used were about 10 millions of each, and in all cases autogenous vaccines were used. The material was obtained free from contamination with mouth organisms by means of a special stomach-tube, which had a long wire with a small bucket at the lower end passed down it, thus obtaining a small sample of the stomach contents uncontaminated by mouth organisms, except in so far as the saliva which had been swallowed into the stomach could not be avoided.

Of **intestinal infections,** the one which has been most extensively treated with vaccines is *colitis*. The vaccine is obtained by plating out the fæces and separating the different organisms. The infective agent is now found by means of the serum reactions of the patient—either the agglutination reaction or the opsonic index. The organism to which the patient's serum shows an increase of agglutinins, or to which it furnishes an abnormal opsonic index, is chosen, and a vaccine is made from it. The doses of the different organisms vary enormously, some cases not being able to stand more than 5 millions, while others will stand 2,000 or 3,000 millions, so that each case must be taken on its merits. The common organisms found to be the cause are the various members of the *B. coli* group and the *streptococcus*, and the infection may be either by a single organism, or by two, or even more, bacteria. *B. pyocyaneus* also is found sometimes, and in several cases very favourable results were obtained with a vaccine of this organism.

The duration of treatment in cases of colitis is always long, and while one case may get well in three months, another apparently similar case will go on for a year or more in spite of treatment. Among other diseases which have been treated with vaccines are *bacillary dysentery* and *typhoid*. Favourable results are reported from India in both of these conditions. In this country typhoid carriers have been treated with vaccines of the typhoid bacillus, with in some cases disappearance of the bacilli from the stools.

Infections of the Genito-Urinary Tract—Gonorrhœa.—This is always due to the *gonococcus*, although when it has become chronic there is often a secondary invasion with some other microbe. The gonococcus can be obtained in culture from the acute case by planting the pus out on serum or blood-agar. In cases of acute urethritis and in chronic cases where there is an infection of the prostate, vaccine therapy must be proceeded with cautiously, as there is a great risk of an overdose causing an epididymitis or cystitis. The dose of gonococcus vaccine varies from ½ million to 50 millions, or even more. If doses of ½ million are given, then they ought to be given at intervals of about twenty-four or forty-eight hours, while the larger doses are given at intervals of one or two weeks. With the larger doses, however, as stated above, there is a risk of inducing unpleasant complications, and the best results are obtained with doses from 2 to 5 millions every two or three days. Vaccine treatment by itself is not so effective for acute gonorrhœa as it is for the chronic infections with the gonococcus, such as gleet, or especially arthritis. In arthritis cases doses of about 2½ to

10 millions, at intervals of a week or rather less, have a very beneficial effect, and form the best method of treatment. It is rare that in a case of arthritis one is able to obtain a culture of the gonococcus, and so make a special vaccine for the patient, so most cases have to be treated with stock gonococcal vaccines; yet in spite of this the results are exceedingly good.

Cystitis.—In addition to gonorrhœal cystitis the organisms mainly responsible for this condition are *B. tuberculosis*, *B. coli* and its allies, and *streptococcus*. Infection by these latter organisms is in all probability from the intestine. The urine must be examined, the infective agent found, and a vaccine prepared. Often it will be found that the streptococcus and one or other variety of the *B. coli* will be found together, when a mixed vaccine must be used. In women especially is it desirable that a catheter specimen of urine be obtained, otherwise misleading results are apt to be obtained owing to external contamination. An anticolon bacillus serum is sometimes used in cases of acute cystitis, but probably the best treatment in all these cases is by means of a vaccine, whether the infection is an acute one or not. The action of the vaccine on the symptoms—*i.e.*, pain and frequency of micturition—is, as a rule, fairly prompt, but in all cases it is a long time before the organisms disappear from the urine.

Pyelitis is treated on exactly the same lines as cystitis. In cases of of stone in the kidney it is very common to find very large quantities of a staphylococcus, and the presence of a stone has in several cases been suspected by the fact that the urine contained many staphylococci, and, later, this has been verified by skiagram. Of course, in these cases it is impossible to cure the condition with a vaccine, but in some cases where an operation was impossible marked alleviation of the symptoms has followed the injections.

Vaginal and Uterine Infections.—Vaginitis has been treated with success in many cases by vaccines of the organisms which are found on examination of the discharge. *Gonococcus* infections are treated in the same way as in the male. *Streptococci* and a small *diphtheroid bacillus* seem to be responsible for many of the infections, and in both cases doses of 5 to 10 millions at weekly intervals seem to be the best treatment for the condition. In such cases the ordinary measures of douching, etc., should not be abandoned.

In infections of the uterus streptococci and the *B. coli* are the most prominent organisms, and vaccines are used for these on the same lines as for similar infections elsewhere.

Infections of the Bones.—In addition to tubercle, which will be considered elsewhere, the only infection which need concern us is **acute osteomyelitis,** which is always due to *staphylococcus*. In these cases operation is practically always necessary, but a vaccine of staphylococcus should be administered as well. These cases are really cases of septicæmia, and the organisms can be found with ease in the circulating blood, so that, as is the case with other septicæmias, the dose of vaccine given must be small, and doses of 2½ to 10 millions are the most suitable for this condition. Even after the acute symptoms have subsided, the vaccine greatly hastens the healing of the very large wound which it is so often necessary to make in the operation.

Infections of the Joints.—These fall into two classes :

1. Where the organisms causing the disease are present in the joint, and can be recovered from it.

2. Where the infection is apparently a distant one, and the organism cannot be recovered from the joint.

Arthritis may be caused by *tubercle*, *staphylococcus*, *streptococcus*, *pneumococcus*, or *gonococcus*. The doses of vaccine and the intervals are the same as those used in other infections with the same organisms, and have been mentioned elsewhere. The important feature of these conditions in connection with vaccine, or, indeed, any other therapy, is to **maintain the limb in a condition of absolute rest** by means of a system of splinting. By this means all damage to the diseased tissues is avoided, and there are no auto-inoculations of bacterial poisons from the area of infection which interfere with the injections of vaccine. In certain suitable cases, instead of inoculation of vaccines, **graduated auto-inoculations** may be induced either by means of Bier's passive congestion or massage.

It is much more difficult to deal with that class of joint infection which is of the nature of **rheumatoid arthritis,** as here the infective agent is much more obscure. The great frequency of this condition in women suggests its being of uterine origin, and in some cases we have seen great improvement result from administration of vaccines, usually streptococcus, made from cultures obtained from the interior of the uterus. In a large number of cases, however, it would seem that the primary infection is of the nature of *pyorrhœa alveolaris*. The organisms found are usually streptococci, but many other bacteria may be responsible for the condition. The method of determining the infection is to isolate the different organisms from the seat of the primary infection, and then test the opsonic index of the patient's serum to each of these before and after massage or exercise of the joints. That organism is selected which shows by a fluctuation of the opsonic index that an auto-inoculation has occurred. In all cases the treatment is a fairly lengthy one, and if in two months one has obtained a definite improvement in the condition, one may feel satisfied.

Tuberculous Infections.—Every region of the body may be attacked by this infection, so that it is better to deal with it in one section. We may leave pulmonary tuberculosis out of the question as belonging to the realms of medicine, but should it complicate any of the more surgical forms of tubercle, great care must be taken in the administration of tuberculin, as the lung cannot be kept at rest, and so auto-inoculations take place which interfere with the doses of tuberculin given under the skin.

The general lines of treatment of all forms of surgical tubercle are the same, being **rest** so far as it is possible for the infected part, and the administration of **tuberculin**, with the aid of direct surgical measures, where necessary. The preparation of tuberculin usually employed is Koch's bacillary emulsion, and the dose employed varies from 0·00001 to 0·001 milligramme of the solid substance.

Taken as a general rule, those cases where there is a great absorption of poisons from the infected focus, such as pulmonary phthisis, will only stand very small doses, while the less extensive infections, and those where the infected part is pretty well shut off from the blood-stream, as in lupus vulgaris, the doses to be used are larger. Cases such as glands and arthritis stand in an intermediate position as regards dosage. It is not possible to obtain the maximum benefit, however, by a simple routine of dosage. Individual cases, clinically very similar, have often to be treated quite differently, one being very sensitive to the tuberculin, and showing a reaction with quite a small dose, while

another will not react to large doses of tuberculin. Where it is possible, blood-tests should be done and the dosage controlled in this way, but at the same time it is absolutely necessary to observe the clinical symptoms, as sometimes the change in the blood is not due to the vaccine injected, but to some auto-inoculation, so that if no account is taken of the patient's condition, the results may be quite misleading.

The best time to test the blood is immediately before, twenty-four hours after, and again four or five days after the inoculation. The test twenty-four hours after will show whether there has been any negative phase following the dose, and the one five days after will show whether there has been a sufficient rise in the index.

If it is impossible to do the blood-tests, as it so often is in practice, then it is well to start with a dose which is less than the average, so as to see whether the patient is very sensitive to tuberculin, and carefully note the clinical signs for twenty-four hours after. If there is nothing to show that there has been any reaction, such as fever or malaise, then in four or five days another inoculation is given of a larger dose, and the dose is gradually increased so long as there is no sign of any reaction.

The doses we begin with in cases of, say, phthisis are 0·00001 or 0·00002 milligramme, and the average dose is about 0·00005. In adenitis and arthritis we begin with about 0·00005, and the average is about 0·0001, while in lupus the dose is about five times as large.

In all tuberculous infections it is very important to observe **whether or not the infection is a pure tuberculous one,** or whether some other organism has obtained access and is aggravating the condition. This latter is practically always the case with open tuberculous foci where there is commonly a secondary infection with staphyloccoci or streptococci. Vaccines made of these secondary infections are of very great benefit, and should always be used.

As regards the prognosis in tuberculous infections, this varies with the region infected. In arthritis the duration of treatment is two years or more, and in many cases complete recovery, with almost perfect movement, has been the result. In adenitis, in most cases the glands have disappeared, or become so small that it is hardly possible to feel them. In this connection it is necessary to say that in very many cases of glands it will be necessary to repeatedly aspirate pus from broken-down glands before the softening process can be stopped.

Lupus not complicated by ulceration does not do well by vaccine therapy alone, and here the treatment should be combined with X rays or Finsen light. Tuberculous ulcers of the skin and subcutaneous tuberculides respond well, however, to tuberculin.

In all cases of infection, where there is any constitutional disturbance, the first effect of a vaccine is to make the patient feel better, although there may be no beneficial effect manifest on the actual lesion, thus showing that the immunizing process has proceeded so far as to neutralize the toxic products which are being absorbed from the lesion.

CHAPTER IV

THE USE OF X RAYS IN SURGERY

Introduction—Interpretation of X-ray photographs—Screen examination—Urinary calculi—Fractures and dislocations (general)—Individual fractures and dislocations—Diseases of bones and joints—Therapeutic use of X rays in surgical affections.

Introduction.

In 1895, Professor Röntgen of Würzburg discovered the X rays. He called them "X rays" because X in algebra represents an unknown quantity. They are now commonly called "Röntgen rays." They have the power of penetrating bodies according to their atomic weights. Thus they pass easily through flesh, and with less ease through bone. When they fall on a screen coated with barium platinocyanide, they cause fluorescence of this salt, and by this means a "screen" examination is made. The rays are produced by electricity, at about 100,000 volts, passing in one direction through a Crookes's tube. The rays arise at the anticathode from a spot about $\frac{1}{16}$ inch in diameter, placed usually at the centre of the X-ray tube. The rays cannot be focussed, but soft X rays can be reflected from the surface of crystals. They act on a photographic plate, and thus a "skiagraph" is made. A lead diaphragm is usually placed between the source of the X rays and the photographic plate. This makes the resulting photograph more distinct.

The object of this chapter is to guide the student and surgeon in the interpretation of X-ray negatives and in making screen examinations, so that he may use the rays to the best advantage. A surgeon need know nothing of the technique for the production of X rays, but he should understand their possibilities and limitations in helping him to form an exact diagnosis.

Interpretation of X-Ray Photographs.

The X-ray photograph is a shadow-picture, and therefore always larger than the original subject. The X-ray negative should be examined, as it is more reliable than a print. It is impossible to reproduce in a print many details which are visible in a negative, and it is possible to have a print so "touched up" that it shows more than the negative. If a negative is blurred so that the details cannot be seen, another should be made. As any part of the body can be X rayed in a few seconds, it is possible to have a sharp X ray of any part. It is sometimes necessary to anæsthetize a child in order to get a good X ray.

It is not always possible in an X-ray photograph to tell the right side from the left, and this information should be furnished by the radiographer. The film side of the plate is usually placed next to the patient, and if one knows the relative positions of the plate, patient, and X-ray tube, while the exposure was made, one can tell the right side from the left. Suppose one looks at the film side of a negative of the kidney region, and the patient says that the plate was placed on his back, then one can tell that the patient's right kidney is to one's left hand. If a print were made from this negative the patient's right kidney would be to one's right hand.

A negative which shows very little detail when examined at a window, or at a naked artificial light, will show much more when viewed by light which passes through opal glass. Special viewing boxes are made for this purpose, having an electric light inside, and a window of opal glass against which the negative is examined. By using such a viewing box, lighted by lamps of a suitable candle-power, one may see the shadows of obscure kidney stones which would be invisible by less suitable light. By tilting the negative to an angle of 60 degrees to

FIG. 2.—VIEWING BOX.

(Leslie Miller.)

the perpendicular, a faint detail may be made more apparent. Sometimes faint details are better seen at a distance of 2 to 3 yards than near at hand. The right and left sides of the patient should be compared whenever it is possible ; they should be taken on the same plate at the same time. When this is not possible, an X ray of the normal should be compared with the one under examination. It is important to decide if a plate is good enough for giving a negative or positive diagnosis. This must be left to the radiographer to decide. From a very thick patient one gets a negative which does not look as good as one from a thin patient. One must be on guard for distortion of the image from faulty technique, photographic blemishes, mercury ointment, buttons, and many other details. If there is any doubt as to detail, a second X-ray negative should be made, and in important kidney cases a second plate should be made after a few days in order to corroborate the first before proceeding to operation.

Examination of Bone.—In examining a bone the following points should be looked for :

1. Outline of the bone, for irregularities due to fracture, exostosis, and detached tendons.
2. Periosteum which is normally invisible, but may be visible when thickened or detached.
3. Cortex which may be increased or decreased in thickness or density.
4. Medulla, which may be increased or decreased in extent or density.
5. General or local atrophy due to disease or disuse.
6. Changes in the trabecular structure.
7. Epiphyseal line.
8. Epiphysis.
9. Ossification.

Lines of separation between muscles, lobulation of fat in superficial fascia, and the depth of the skin, can all be shown in suitable cases.

When a toe grows gangrenous, and the surgeon has to decide where to amputate, the arteries of the limb should be X rayed, as calcareous arteries throw distinct shadows. Normal arteries are usually not shown by X rays.

The following tendons can be easily shown by X rays : Ligamentum patellæ, tendo Achillis, quadriceps, and hamstring tendons. Other tendons show less distinctly, or may not show at all.

A calculus which contains denser material than muscle tissue casts a shadow, but those which are not so dense as muscle tissue cast little or no shadow.

Biliary calculi of pure cholesterin do not cast shadows, and cannot be demonstrated by X rays. It is possible for a biliary calculus to be radiographed provided it has a layer of lime salts, and with special technique such biliary calculi have been demonstrated by X rays.

Secondary growths in the liver cannot, as a rule, be shown on a plate, though secondary deposits in the lungs can be demonstrated. This is due to the great contrast between the dense secondary growth and the transparent lung tissue.

Flatus in the intestines, by making the part more transparent to the X rays, makes a very definite mark on the plate.

Chips of glass in the hand can usually be seen on a plate, but **thorns** do not appear.

Green-stick fractures and impacted fractures may be seen on a plate when it is impossible to see them on the screen. In examining a skiagraph of the neck of the femur, the amount of rotation outwards of the foot must be considered. If the foot is rotated out, the neck of the femur appears short; and if the foot is kept quite straight, the full length of the neck of the femur is shown.

It is impossible to tell at what **depth a foreign body** lies from the examination of a single negative. The nearer a foreign body is to the plate during the time of exposure, the sharper will be its outline. Thus, if two similar foreign bodies are represented in a negative, the one with the sharper outline is the one nearer to the plate. For exact localization special methods must be used.

A screen examination may fail to show a fracture when a plate shows it clearly. Examination of the chest should be by both screen and plate, as each has its sphere of usefulness. The screen examination during removal of a foreign body is sometimes a necessity, even after it has been carefully localized.

Dislocations are usually evident on a skiagraph, but some joints require stereoscopic views to show their condition. The elbow, wrist, and ankle, and in a few cases the shoulder, may require stereoscopic views for a correct diagnosis of dislocation.

Callus casts a shadow, and can be recognized during union of bones. It usually appears in a radiograph four weeks after a fracture.

The difference cast by the shadows of pus and serum is so small that for practical purposes it does not exist.

Tumours may cast very little or no shadow, unless they are very large, bony, or calcified.

Brain tumours are hard to show by X rays, but their presence has been confirmed by this method.

Early carcinoma in the stomach casts no pathognomonic shadow.

A negative shows most detail when it is dry. When it is partly damp, the damp part appears lighter than the dry part, and if this is not noticed, it could give rise to a mistake in diagnosis. A damp circle in the region of the kidney appears like a stone when the rest of the plate is dry.

A normal radiograph of the bones of the knee and shoulder is frequently got when the patient has great pain in these regions because it is the soft parts which are at fault, and it is often impossible to show sufficient detail in the soft parts to make a radiograph of value.

Screen Examination.

In order to make a thorough screen examination one must have been in the dark for at least ten minutes. By that time the fatigue of the retina has passed off, and the eye is prepared to see what it otherwise could not see. Students and their teacher often walk into the dark X-ray room to see a patient with renal calculus, and while the radiographer is pointing out the stone and its position in the kidney, someone remarks : " Where is the screen ?" He cannot see the screen, while the X-ray worker, who has been in the dark for a long time, can see not only the screen, but also the shadow of the kidney and the stone. Within ten minutes the student can see just as well.

A **lead diaphragm** is most essential for cutting off all extraneous rays when making a screen examination. Without a diaphragm it may be impossible to see a needle in the hand, while with the diaphragm it may be quite easy. The X-ray tube should be so arranged that it is easily moved about. It should be under the X-ray couch, and should be well protected by lead so as not to let the X rays fall on the operators nor the spectators.

Screen examination of **the head,** except for foreign bodies, is of little value. A screen examination of **the abdomen** should show the pelvic bones and vertebræ, the outline of the kidneys and liver, flatus in the intestine, metallic foreign bodies, and frequently a renal calculus when one is present. Soft tumours in the abdomen do not appear unless they are very large. Coins in the abdomen can be seen on the fluorescent screen, and do not, as a rule, require a skiagraph for confirmation. The same is true of a metal squeaker out of a rubber doll, which is frequently swallowed by children. Coins, false teeth, and other dense foreign bodies can be seen in the œsophagus, and skiagraphed. Coins usually lie opposite the upper border of the sternum. A swallowed pin may not be visible by screen examination, but should

be evident in a skiagraph which has been made while the patient held his breath.

Stricture of the œsophagus can be shown best by screen examination. The patient is examined upright. The X-ray tube should be behind him, and the fluorescent screen placed on his chest. His right side should be a little nearer the observer than his left, so as to allow the rays to pass between the vertebral column and the heart.

In making diagnosis between spasmodic and organic stricture the patient should be made to swallow first a large cachet of bismuth, followed by a little water, and then, after a few minutes, several mouthfuls of bread-and-milk, mixed with bismuth. The following differences will then be seen :

In **organic stricture** the cachet sticks above the stricture, and after swallowing a little water it slowly trickles through. If the stricture is nearly complete, a few mouthfuls of bread-and-milk, mixed with bismuth, can be seen to collect above the stricture, and not pass through it. Soon the food is regurgitated.

In **spasmodic stricture** the cachet sticks above the stricture, and water swallowed does not pass it on. A few mouthfuls of bread-and-milk, mixed with bismuth, should then be given. This will be seen to collect above the stricture, and may remain there for some time, till suddenly the whole lot is released, and passes down *en masse*. More bismuth food given then passes easily.

In **partial organic stricture** bismuth food will be seen to collect above the stricture, and pass very slowly through it.

Aneurism should be looked for at the same time. The differential diagnosis between aneurism, enlarged glands, and new growths, is usually possible. Abdominal aneurism can be seen in an antero-posterior skiagraph of the abdomen. It is difficult to show, and is not very distinct when it is shown.

X-Ray Examination of the Alimentary Tract.

An opaque meal, consisting of 2 to 6 ounces of barium sulphate, mixed with ¾ pint of buttermilk, is given. The examination should be made by screen and plates. The following conditions can then be shown:

1. **Œsophagus.**—Stricture of œsophagus, œsophageal pouch, and spasm of the œsophagus.

2. **Stomach.**—**Carcinoma** appears as a permanent indentation resembling finger-prints in a mass of putty. The opaque meal must be given on an empty stomach, and the appearance must be confirmed by a second photograph taken at least fifteen minutes after the first. Peristaltic waves come to a stop on reaching the carcinomatous area. The stomach should be examined antero-posteriorly and laterally, standing up and laying down, prone and supine. When carcinoma is shown by X rays to involve one-third of the stomach area, operation is useless.

Ulcer.—Penetrating ulcer, which has formed a crater depression in the lesser curvature of the stomach, presents the following characteristics:

1. It is accompanied by hour-glass contraction.

2. The upper sac fills up as the patient swallows, and after a minute or two fluid passes slowly through the constriction into the lower sac.

3. The crater fills up with the opaque meal, and presents a horizontal upper border, with a bubble of gas above the horizontal line.

Gastroptosis is easily demonstrated. When standing erect, the lowest border of the ptosed stomach may reach 4 inches below the level of the iliac crest, and yet when lying supine it may rise 2 inches above the same level.

Pyloric stenosis is characterized by the opaque meal remaining in the stomach longer than six hours. According to the duration and severity of the stenosis, the stomach grows proportionately dilated. The greater curvature widens out from its usual J appearance to the shape of the head of a hockey-stick, the pylorus passing farther to the right than usual. The peristaltic indentations are increased in depth. Three to six minutes may elapse between the peristaltic contractions, and during the period of peristalsis a feeling of discomfort is experienced, usually described by the patient as a feeling of "wind in the *stomach.*" Three causes of stenosis about the pylorus can be recognized:

1. *Carcinoma*, in which the finger-print indentations can be recognized.
2. *Duodenal stenosis*, in which the first part of the duodenum is defective in the skiagraph.
3. Simple contraction of the pylorus, where evidence of carcinoma is absent, and the first part of duodenum is perfect.

Duodenum.—By means of serial radiography one can demonstrate imperfections in the first part of the duodenum. These imperfections may be due to adhesions, contractions from duodenal ulceration, and other causes.

Ileal stasis is diagnosed by giving an opaque meal at midnight, and examining it after twelve hours. It should by that time be in the cæcum or farther on, and none should be in the small intestine. No other food must be given from midnight until breakfast. If some of the opaque meal remains in the ileum, the cause of the delay should be sought for in the parts above the ileum, and if no delay is found in the jejunum, duodenum, or stomach, one is safe in concluding that the delay occurs in the ileum.

Appendix.—When the appendix is filled by some of the opaque meal, and remains filled for more than three days, one may conclude that the appendix is a source of danger. The appendix should fill and empty with the opaque meal in the same length of time at the cæcum. When it does not fill, one should regard the appendix with suspicion, as it may be already full, or stenosed near the cæcum.

Large Intestine.—An opaque enema reveals stenosis and carcinoma of the large intestine.

Adhesions are demonstrated by screen examination, by palpating the barium-filled organs, also by the change in their position when lying down and erect. Much experience is necessary for the correct diagnosis of adhesions.

The **ileo-cæcal valve** may be incompetent, and this condition is revealed by the passage of the opaque enema into the small intestine.

The opaque meal outlines the stomach as a J-shaped body. The first part of the duodenum (lying prone) appears as a small cone-shaped body capping the pylorus. The second and third parts of the duodenum are recognized by their network appearance, the jejunum by a network and spotted appearance. The ileum appears as a coiled thin sausage. The large intestine is characterized by its haustra. All radiographs of the opaque meal should be made in less than a second of time.

Urinary Calculus.

A patient with symptoms of urinary calculus should be radiographed so as to show both kidneys, both ureters in their entire length, and the whole of the bladder. This is necessary, as symptoms pointing to stone on one side of the body may be due to a stone on the other side. Symptoms of stone in the bladder may be due to stone in the kidney, and *vice versa*. A patient should be prepared for radiography by castor oil or a vegetable laxative the night before. Calomel should not be given, as it might cause a shadow. An enema should be given immediately before the radiograph is made. The patient should not have had a meal for twelve hours previous to the X-ray examination.

Renal calculi can frequently be seen on the fluorescent screen, but there are some which can be radiographed which cannot be seen on the screen. A negative which shows the outline of the psoas muscle and the lower pole of the kidney clearly, and which has been taken while the patient has held his breath, is good enough for giving a negative or positive diagnosis as to stone. When the lower pole of the kidney is blurred, it indicates that the patient has moved his kidney by breathing, and a small stone may be made invisible by this movement. If the negative does not show the outline of the psoas muscle, it is possible to make a better skiagraph; and if the diagnosis is doubtful, a better negative should be made. It may be impossible to get a satisfactory radiograph in the case of a very fat patient. The radiograph should be made while the patient holds his breath. Frequently the outline of only one kidney appears. This is usually the left kidney. It is due to the distension by gas of the descending colon, which presses on the kidney, and thus outlines its edge. The outline of the lower poles of the kidneys can be made more evident by inflating the large intestine with air by a Higginson's syringe, but this method is not recommended for the purpose of showing renal calculi. A calculus of oxalate of lime casts the darkest shadow. Cystine stones come next in density, followed by phosphate of lime. Mixed phosphate stones cast still less shadow, and last in order come uric acid stones, which may cast no shadow at all. A stone of exactly the same density as the kidney may cast no shadow at all.

Renal Calculus.—A negative showing stone in the kidney should conform to the following points:

The stone should be in the **position** of the kidney. It is possible to have two radiographs of a stone showing the stone in different positions. This is caused by the relative position of the X-ray tube, the stone, and the photographic plate. Thus, when the shadow of a stone coincides with that of the last rib, it is possible, by changing the position of the X-ray tube, to project the shadow of the stone clear of the last rib.

When a stone can be seen on the fluorescent screen, it will be seen to move freely with respiration. A **range of motion** of 1 to 1½ inches is usual. When the kidney is fixed by operation, there may be on movement of the stone with respiration. The position of the kidney varies a great deal, but usually renal calculi lie to the inner side of a line drawn vertically upwards from the highest point of the iliac crest. Calculi in the kidney may appear above the level of the last rib, and below the level of the crest of the ilium, though such extreme positions are rare.

PLATE III.

Renal Calculus.

[To face page 38.

The **density** of its shadow may vary from little more than that of the shadow of the psoas to, or beyond, that of the densest part of a lumbar vertebra. There may be one or many. A single radiograph cannot decide the number of stones present, but it is possible to tell the number by stereoscopic radiographs. Several widely separated stones in the region of the kidney, especially at its periphery, may indicate hydronephrosis.

Fallacies which simulate stone in the kidney are—

1. **Blemishes** in the plate. These have usually sharper edges than a stone, and they are usually multiple, though not necessarily so. The radiograph of a stone always has less clearly defined edges than a blemish in the plate.

2. **Calcified Lymphatic Glands.**—These are usually found lower down than the position of the kidney. They are round or oval, and present a granular appearance, unlike the homogeneous appearance caused by a calculus. The granular appearance is seen in good radiographs only. A calculus may cast a shadow in which concentric lines are visible. A small calcified gland casting a shadow in the position of the kidney could be mistaken for a calculus, and unless an indication of its nature was given by the presence of other calcified glands, a mistake might easily be made. Calcified glands most frequently cast a shadow about the brim of the pelvis and along the side of the spinal column. They do not move so freely on deep respirations as stones in the kidney.

3. **Scybalous masses** are frequently outside the position of the kidney.

4. **Bismuth,** which the patient may have swallowed.

5. **Concretions, or Foreign Bodies in the Appendix.**—These usually lie outside the line of the kidney.

6. **Atheroma** of vessels.

7. **Myositis ossificans and Osteo-arthritis.**—In such cases well-marked signs would be probably found elsewhere.

8. **Putty-like mass** found in old tuberculous kidney. This may cast a shadow indistinguishable from stone, or its shadow may be streaky and ill-defined, and occupy nearly the whole kidney region. In this case the lowest part of the shadow may be the densest, as the heavy lime-salts tend to gravitate.

9. **Extraneous bodies,** such as a pigmented mole on the skin, mercury or lead ointment, or other foreign body which may have got between the patient and the plate.

10. **Calcified costal cartilage** may cast a shadow like renal calculus. Stereoscopic views show the real position of the calcified cartilage. A shadow which looks like a stone, but which cannot be confirmed by subsequent photographs, should not be considered as stone.

X rays have been used in the operating theatre at the time of operation, in order to ascertain where a stone lies in the kidney before opening it. After the kidney has been delivered it is placed in the path of the X rays, and the surgeon looks at the shadow of the kidney on a fluorescent screen placed in a cryptoscope. He can thus locate exactly the position of the stone before opening the kidney.

Once a stone has been seen on a plate, there is a strong probability that it can be seen on the fluorescent screen, provided that—

1. The patient is not too fat, and plenty of fluorescence can be seen on the screen.

2. The examiner has been in the dark for at least ten minutes, so as to remove the fatigue of the retina.
3. A diaphragm is used to stop off all X rays except over an area half the size of the kidney.

It can be made out more distinctly once it is located by making the patient breathe deeply, and then the stone and kidney will be seen to rise and fall from 1 to 1½ inches.

Ureteric Calculus.—A ureteric calculus is mainly distinguished by its position, shape, and size.

The **position** of the ureter on an X-ray negative is indicated by a line drawn from the tip of the transverse process of the second lumbar vertebra downwards across the transverse processes of the third, fourth, and fifth lumbar vertebræ to and along the sacro-iliac synchondrosis, and thence towards the symphysis pubis nearly concentric with the pelvic brim at a distance of about an inch from the brim. Ureteric stones frequently are found where the ureter is narrowest, but may be found elsewhere. They may change their position from day to day, not only downwards, but also upwards.

Calcified glands are specially common in the position of the ureter as it lies over the sacro-iliac synchondrosis, and are liable to be mistaken for ureteric stones. They are usually larger than ureteric stones.

Shape.—The shape of a ureteric stone is usually oval or elongated. When a stone blocks the ureter, there may be a deposit of crystals above the stone, and these cast a shadow, so that a streak is got on the plate. Calcified arteries are frequently found in the pelvis of an elderly patient. Their shadows are bilateral. The long axis of a ureteric stone is usually directed towards the bladder. This is important for distinguishing ureteric stone in the pelvis from stone in the bladder. Stone in the bladder generally lies more transversely, while ureteric stone lies more in the direction of the ureter.

Size.—Small ureteric calculi do not usually demand operative treatment. A radiograph made later on may show that the stone has passed away. A stone in the ureter may, however, become encysted, and then it may become as large as a vesical calculus.

Fallacies.—The same fallacies may be met with in connection with ureteric stone as are found in cases of renal stone.

In doubtful cases stereoscopic radiographs should be made with a metallic bougie in the ureter in order to show the relative position of a doubtful stone in the ureter. Specially opaque X-ray bougies are made for the purpose. But even this method is not absolutely reliable, as a calcified gland has been found which surrounded the ureter, and which cast a shadow indistinguishable from a ureteric stone.

In the position of the ureter in the pelvis there are frequently small shadows which closely resemble ureteric calculi. These are usually caused by **phleboliths** in the pelvic veins, and are comparatively common. They *may be distinguished from ureteric calculi* in some cases by—

1. Their relative position to the ureter when a bougie, which is opaque to X rays, is passed into the ureter. They are seen to be placed at a distance from the bougie.
2. They are usually multiple, and may lie in a line. When this line does not correspond with that of the ureter, it is in favour of a diagnosis of phleboliths.

3. Their shadow is clearer than that of a ureteric calculus.
4. They are often round, but may be oval.
5. They may cause no symptoms of stone.
6. Stereoscopically they may be shown to lie in several planes.

Vesical Calculus.—Vesical stones usually cast oval shadows, and lie transversely. They are, as a rule, diagnosed without the help of X rays. The rays are used only as a confirmatory diagnosis. A radiograph of a vesical stone is only likely to be confused with one of a stone in the lower end of a dilated ureter. The vesical stone usually lies with its long axis more or less transverse, while the ureteric stone has its long axis more or less in the line of the ureter.

Scybalous masses may cast shadows like vesical calculi, but these scybala are usually indented, whereas vesical calculi are usually oval, with no indentation. The bladder can be made very distinct in a radiogram if it is filled with air while it is being radiographed. A uric acid stone may cast no shadow.

Fractures.

Screen examination shows a gross fracture, but certain fractures cannot be recognized by screen examination. The latter include greenstick fractures, cracks in bones with no displacement, small chips, partly detached from the bone, and fractures of the phalanges caused by crushing. Wherever there is displacement of fragments, the fracture can be seen on screen examination, provided one fragment does not cover exactly the other fragment ; therefore, a fracture should always be looked at in two planes. When a radiograph of a fracture is required, metal splints should be used as little as possible, as a fracture cannot be shown satisfactorily through a metal splint. All splints and bandages should be removed whenever it is possible, as they cast shadows. Plaster of Paris, iodoform, adhesive plaster, thick layers of cyanide gauze, lead lotion, mercury ointment, and rubber protective tissue, cast fairly deep shadows, and should be removed before screen or photographic examination. The screen examination of every fracture can be made most conveniently with the X-ray tube below the couch. A cryptoscope should be used as little as possible. When it is impossible to darken the room, it is best to make the screen examination at night. A fracture which will make a useful limb often looks very bad on the screen; therefore, never let the patient examine the screen.

The fragments usually lie side by side, not end to end, in a well-set fracture.

Fractures are practically never set end to end, unless operated on. When set end to end the fragments unite usually at an angle, and not in a straight line. The method of union is shown by the radiographs. The redundant bone is absorbed where it is not required, and new bone is thrown out where it is required. Callus and old bone are moulded so that, though the fragments united side by side, the final result is a straight, or very nearly straight, bone. It is not advisable to set a fracture while watching the result on the fluorescent screen.

In some cases, even under an anæsthetic, it is not possible to bring the fragments end to end ; this is specially true of fractures of the lower end of the humerus, involving the elbow. Even when it is possible to bring the bones end to end it is not possible often to keep them so. Harm can be done by too much X-ray examination, and too many trials to get the bones into better position. A well-united

fracture shows the line of fracture for years after good union has taken place.

When it is difficult to make out in a radiograph whether or not there is a fracture, the best guide is the edge of the bone, where a slight want of continuity indicates the beginning of the line of fracture.

About four weeks after a fracture, callus formation may be shown in a radiograph, but it may appear earlier or later. It may be seen in a radiograph after six months, but it may disappear before that time. Callus appears homogeneous in a radiograph, with no trabecular structure, as seen in normal bone.

Injuries to the Bones of the Head and Trunk.

Skull.—X rays may help to localize a cerebral tumour, but their help in this direction is limited, and depends on the density of the tumour. Fracture of the calvaria can be shown, but not of the base of the skull, except in exceptional circumstances. The grooves for arteries and the fissures show distinctly on a plate. Bullets in the skull or brain are easily recognized by X rays.

The frontal sinus can be clearly shown in a negative ; its size and shape can be defined. If one frontal sinus is filled with pus, it casts a denser shadow than the normal one, and thus the X rays aid in the diagnosis of frontal sinus disease. The same is true of the antra, ethmoidal, and sphenoidal sinuses, but it is less easy to make out their position in an X-ray photograph, whereas the frontal sinuses can easily be located. The sphenoidal sinuses can be exactly located by passing in a probe, and then taking antero-posterior and lateral views. Fracture or displacement of the nasal bones can be made out by means of X rays.

Mastoids.—The air cells in a normal mastoid are clearly shown in a radiograph. When these air cells are filled with pus or granulations, the change is visible in an X-ray plate.

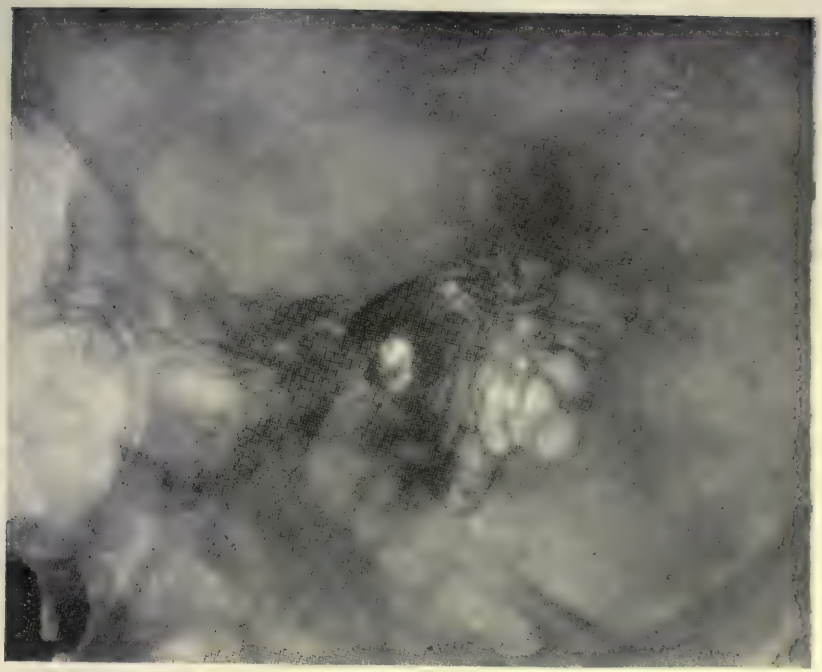
Chronic Mastoiditis shows absence of the air spaces, the sclerosed portion is very opaque to X rays, and the anterior border of the lateral sinus casts a crescentic shadow not seen in the normal (see Plate IV).

Acute Mastoiditis shows the air cells less distinctly than on the normal side, but no crescentic line is present (see Plate IV). In all mastoid cases both right and left mastoids must be shown for comparison.

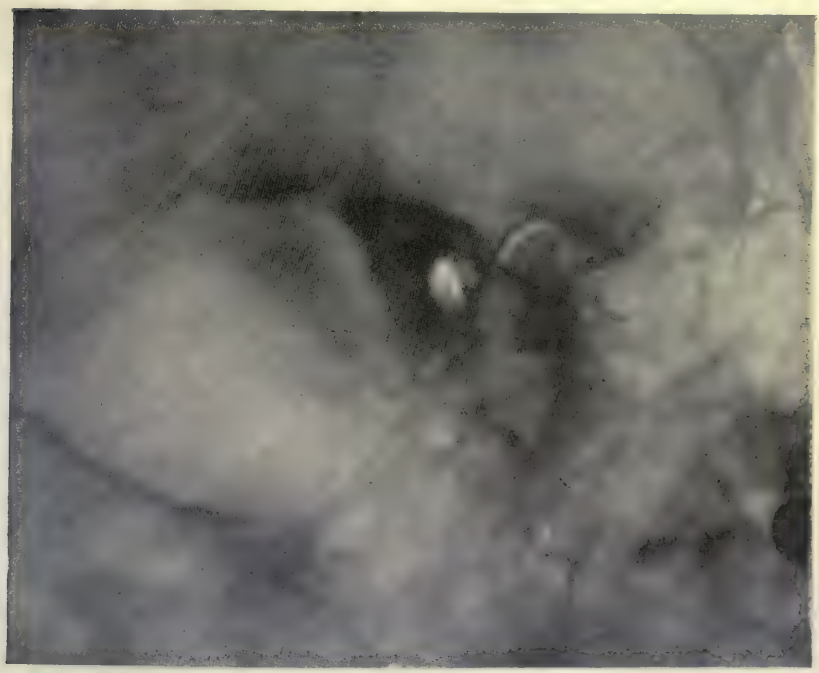
Teeth.—Much useful information regarding teeth can be got from the use of X rays. In every case it is necessary to make an X-ray photo, as the screen does not help much for the teeth. The photographic plate may be placed inside or outside the mouth. When placed inside the mouth, it will only show two or at most three teeth distinctly. The clearest results are got when a photographic film is placed inside the mouth, and a skiagraph made on it of the affected tooth.

The conditions in which X rays prove of use are the following :

1. Unerupted teeth can be shown lying buried in the jaw, and their position and direction can be ascertained.
2. Supernumerary unerupted teeth can be similarly diagnosed.
3. Absence of teeth.
4. Presence of buried stumps.
5. Abscess at root of tooth. The abscess shows in the negative as a less dense area than its surroundings.



(A)



(B)

CHRONIC MASTOIDITIS.

(A) The normal left side presents the characteristic appearance of a normal mastoid, whilst (B) shows the pathognomonic crescentic line of chronic mastoiditis. The air cells have disappeared, and the petrous bone stands out in great contrast. The crescentic line is the upper and front margin of the lateral sinus. The lower margin of the sinus does not appear.

(Archives of the Roentgen Ray, September, 1912.)

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6. A piece of a broken dental instrument in a tooth can be shown on a plate.

7. The extent of fillings can be shown. This is specially useful for root canal fillings.

8. The direction of the roots of the teeth can be shown with a view to straightening irregular teeth.

The Lower Jaw.—Fracture of the lower jaw is easily shown by a negative. The articulation of the lower jaw can be shown by antero-posterior and lateral views. Necrosis of the lower jaw appears in a negative as a light area.

Foreign Bodies in the Eye can be localized to within 1 millimetre by McKenzie Davidson's method, and by other methods based on the same principle.

The Neck.—The thyroid, hyoid, epiglottis, and trachea, can usually be seen in a side view. A new growth in these parts can be shown by X rays when it is denser than the surrounding soft parts. **Fracture and dislocation in the spinal column** can be shown. Each fracture must be radiographed according to its position. For the first three cervical vertebræ, stereoscopic lateral views are best. The atlas and the axis can be shown in an antero-posterior view made by directing the rays through the patient's widely open mouth. For the other cervical vertebræ lateral and antero-posterior views may be used ; for the dorsal vertebræ the semilateral position is best. Stereoscopic views should be made if the diagnosis is not clear from one negative alone. An antero-posterior view of the lower dorsal vertebræ is sometimes unsatisfactory, owing to the antero-posterior thickness of the vertebræ, and to the superimposed structures. A lateral view is also indistinct, due to the distance the plate must be from the bones when the radiograph is made.

The lumbar vertebræ and sacrum are well seen by antero-posterior stereoscopic views.

Pelvis.—Fractured pelvis is easily shown when the fracture occurs through the pubis, as it usually does. An antero-posterior view is the only practical one. Fracture through the ilium can also be shown in an antero-posterior view. The head of the femur may be driven through the acetabulum, and an antero-posterior view shows this plainly.

Ribs.—Fractured ribs cannot easily be shown by X rays, as the fracture occurs at the side of the body, and there is not usually much displacement. A lateral view is the only one possible to show such a fracture, but so many structures lie between the fracture and the source of X rays that the resulting skiagraph is difficult to interpret. An antero-posterior view will show the fracture when there is great displacement of the fragments, or when the fracture occurs near the spine. When the fracture is exactly lateral, an oblique view, with the X-ray tube placed close to the body, may show the fracture. The costal cartilages cast no shadows. Calcification of the cartilages should be kept in mind in elderly patients. It usually is most marked along the lower border of the cartilage. Cartilage casts no greater shadow than muscle, therefore the cartilaginous ends of the bones do not appear in a radiograph. Calcified cartilage, as in the rib cartilages of old people, throws a distinct shadow.

Fusion of the ribs can be well shown in antero-posterior and semi-oblique positions. Torticollis due to a cervical rib has been detected in an antero-posterior view.

Cervical ribs are easily shown in an antero-posterior view. They are shorter than the first rib ; they seldom cross the clavicle, as the first rib does in a radiograph, and they have a free rounded extremity. A cervical rib may be so long that it looks like a normal first rib. In such a case all the ribs should be taken on one plate, and counted. In other cases the cervical rib may be only ½ inch long. They are frequently found in normal chests, and may give rise to no symptoms.

Sternum.—The sternum can best be shown by a strictly lateral view, and by a nearly antero-posterior view, when the shadow of the vertebral column is kept clear of the sternum. The xiphoid cartilage can be shown when calcified.

INJURIES TO THE BONES OF THE UPPER EXTREMITIES.

The Hand.

Phalanges.—The plate should show antero-posterior and lateral views of the phalanges of both hands. A fracture in a phalanx is very difficult to see with the screen, but it is easily seen in a skiagraph. A terminal phalanx may be crushed and the skiagraph shows a comminuted fracture. A small fragment may be knocked off the base of a terminal phalanx, and can best be shown by a lateral view. Real dislocation at a phalangeal joint seldom comes for X-ray diagnosis, but subluxation is not uncommonly seen between the phalanges. The right and left corresponding phalanges should be compared by lateral views on the same plate. An apparent subluxation may be normal when comparison is made with the healthy side ; but a slight subluxation might not be noticed if one has not the healthy side with which to compare it.

Dislocation of a metacarpo-phalangeal joint is best shown by a lateral view, in which the unaffected fingers are bent forward out of the way of the affected one. An antero-posterior view is also characteristic, as the end of one bone overlaps the other.

Metacarpals.—An antero-posterior view is usually sufficient. A lateral view of the metacarpals is unsatisfactory, due to superposition of the bones. Stereoscopic views are best for showing the displacement in a fractured metacarpal. It frequently happens that more than one metacarpal is fractured. One should make a stereoscopic examination of all the metacarpals at once.

Fracture is usually through the shaft, next frequently through the base. In the first metacarpal the fracture is frequently at the base, and the proximal fragment is displaced inwards. One or more metacarpals may be found deformed, and much shorter than the others. The corresponding fingers appear shorter than usual.

Carpus.—A vague diagnosis of "sprained wrist" is frequently cleared up by a skiagraph. An early and accurate diagnosis in such cases may make the difference between a useful and a useless joint. Fracture and dislocation of the carpal bones are common accidents, and can seldom be correctly diagnosed without the aid of X rays. Inability to extend the wrist with slight abduction, and pain on pressure over one of the carpal bones, should suggest the possibility of a fractured carpal bone. Most cases of fracture or dislocation of the carpal bones cannot be seen by screen examination. A skiagraph

is necessary in these cases. Stereoscopic views are of value, as a lateral view of the wrist is often unsatisfactory. Both carpi should be shown on the same plate for comparison. Where this is not possible, a skigraph of a normal wrist should be compared with the abnormal. Great care should be taken that the normal wrist has been taken under exactly the same conditions as the injured one. For this reason it is best to have a skiagraph of both wrists taken at the same time, in exactly the same positions, on one plate. If the skiagraph of the injured wrist be compared with a normal wrist in an atlas, many differences in the shadows of the carpal bones will be detected. These may be wholly due to the different conditions under which the skiagraphs were taken, and not really to any abnormality.

A fractured carpal bone may be met with, and should be looked for, in cases of fracture of the radius, ulna, or a metacarpal bone. By far the most frequently fractured bone in the carpus is the scaphoid. The os magnum and semilunar are less frequently fractured, and the other carpal bones still more rarely. Simple fracture of a carpal bone is not usually accompanied by ecchymosis, and there may be very little or no localized tumour.

Scaphoid.—Symptoms of this fracture are—

1. Inability to extend the wrist beyond a straight line, while the ability to flex it remains almost as good as in the normal hand.
2. Slight abduction of the hand.
3. Pain on pressure over the scaphoid.
4. A weak grasp.

Antero-posterior skiagraphs of both wrists should be compared, for by that means the fractured scaphoid is easily detected. In old-standing cases the line of union shows in a skiagraph for four years or more, and must not be mistaken for non-union. On counting the number of bones in the carpus, one finds that there are at first sight nine when the scaphoid is fractured, as it breaks into two fairly equal parts.

Os Magnum.—The fractured bone should be compared with the normal one of the other side, but even then the fracture may not be very evident. Stereoscopic views at once make the diagnosis clear.

Semilunar.—Antero-posterior views of right and left sides should be compared, and the fractured semilunar will easily be detected.

Fracture of the **other bones of the carpus** may be found, but they are comparatively rare. Stereoscopic views are best for their detection.

Dislocation of Carpal Bones.—The following **varieties** of dislocation of the carpal bones have been met with by X-ray examination: (1) Semilunar forwards, and os magnum backwards; (2) semilunar backwards, and os magnum forwards; (3) scaphoid forwards; (4) scaphoid backwards; (5) scaphoid outwards; (6) trapezium forwards; (7) trapezoid backwards; (8) trapezoid forwards; (9) scaphoid and semilunar forwards together; (10) proximal row forwards on distal row. Partial dislocation may also be found due to ruptured ligaments. The deformity caused by a dislocated carpal bone resembles a Colles's fracture, and X rays are required for a correct diagnosis. Old-standing cases of "severe sprain" may be found to be due to a dislocated carpal bone. A fractured scaphoid may be found along with dislocation of one of the carpal bones.

The **os magnum** may be incompletely dislocated backwards. Stereoscopic views should be used for its diagnosis.

The **unciform** is seldom dislocated. It has been found dislocated backwards, and is best diagnosed by stereoscopic views.

The **trapezium** has been found dislocated forwards and backwards. Stereoscopic views should be used for its diagnosis.

Scaphoid.—Antero-posterior and lateral views should be made of both wrists on the same plate, to show dislocation of the scaphoid. Stereoscopic views should be used if the former are not satisfactory.

Semilunar.—This bone may be dislocated backwards or forwards. Stereoscopic views show the condition best. A single antero-posterior view is nearly useless, as an aid to diagnosis in this dislocation. Dislocation of the proximal row of bones forwards on to the distal row may occur. Stereoscopic views are best for diagnosis of this condition.

In cases of injury about a wrist, one should never be satisfied with a single antero-posterior skiagraph, for with this alone one may miss a fracture of a carpal bone as well as a dislocation. One should have antero-posterior and lateral views of both wrists, the injured and the normal, and if with these the diagnosis is not quite clear, the final proof is furnished by stereoscopic views.

Foreign Bodies in the Hand.—The position of *bullets* can usually be sufficiently accurately diagnosed by a strictly antero-posterior and a strictly lateral view. Stereoscopic views are also of great value.

Needle in the Hand.*—An antero-posterior and lateral view should be obtained before proceeding to operation. When possible, a stereoscopic view should also be examined. Having decided where the needle is, and its exact position and direction, an incision should be made across the needle near its most superficial end. After cutting down to the depth of where it is thought it is lying, and it has not been found, a pin, cut to the depth of the wound, should be inserted to the bottom of the wound, the head of the pin lying flush with the surface. A screen examination should then be made, and the relative position of the needle to the point of the pin noted. The operation should be proceeded with, and this manœuvre repeated as often as necessary.

The outline of the finger-nail often appears in a skiagraph, sometimes due to the curve of the nail, and sometimes due to dirt, which is opaque to X rays. This should be remembered in connection with foreign bodies.

Fracture of Ulna.

Lower End.—An antero-posterior view frequently shows that the styloid process of the ulna is broken off. This often occurs in cases of Colles's fracture. The broken fragment resembles a sesamoid bone, but has one rough surface. It is not much displaced as a rule. The lower epiphysis may be separated from the shaft, but more often there is fracture through the lower end of the diaphysis, so that the separated fragment contains the line of the epiphysis.

When the **Shaft** of the ulna is fractured, the relative position of the fragments can be shown by lateral and antero-posterior skiagraphs. A partial fracture, or green-stick fracture, demands both views.

Upper End.—Fracture of the olecranon demands only a lateral view, and is easily detected by X rays. A skiagraph taken after wiring makes a gratifying picture both to patient and surgeon. An

* Absolute localization of a foreign body is done by McKenzie Davidson's method. It is too technical to describe here. See *Archives of Röntgen Ray*, May, 1898.

antero-posterior view of the normal elbow has been wrongly diagnosed as a fractured olecranon, because there is an apparent want of continuity between the olecranon and the shaft. This appearance is due to the X rays passing easily between the humerus and the ulna ; it merely needs to be pointed out in order to avoid the possible mistake. A lateral view would show no fracture in such a case.

The olecranon, when fractured, is usually separated from the shaft by an interval of $\frac{1}{2}$ to 1 inch. The olecranon may show a comminuted fracture, in which the parts lie close together, and in such a case wiring would not be advisable. A spicule of bone may be detached from the olecranon, and can usually be shown by a lateral view. The olecranon and the head of the radius may be fractured at the same time. A semilateral view shows the condition.

The epiphysis, which caps the olecranon, is normally separated from the shaft by $\frac{1}{8}$ inch in a radiograph of a child between ten and seventeen years of age. If, in a good skiagraph, it appears to be separated more than $\frac{3}{8}$ inch, the condition should be considered abnormal.

The coracoid process may be broken off, and shows in a lateral view.

Fracture of the Shafts of Radius and Ulna.

In this fracture a single skiagraph is usually misleading. A strictly antero-posterior and a strictly lateral one will give a good idea of the position of the bones, but a stereoscopic view is still better. It is almost impossible to get the bones to unite end to end. In this, as in almost every fracture treated without operation, the ends of the bones lie side by side, and one must be content with this position provided there is a good space left between the radius and ulna.

After the fracture has been set an antero-posterior and a lateral view should be made, and if it is found in the antero-posterior view that the fragments are in a straight line while in a lateral view they are seen lying side by side, then the fracture should be considered well set so far as X rays can help the surgeon. Sometimes the upper fragments lie anterior to the lower, and sometimes the reverse. It is quite unusual to get the bones to join end to end without overlapping, except in green-stick fractures of both bones. When the bones are made to unite end to end, there is an angle formed between the fragments even when they are wired together.

Fracture of Radius.

Colles's Fracture.—The plate should show on one half an antero-posterior view, and on the other half a lateral view of the wrist. The antero-posterior view in some cases shows very little indication of the fracture, and requires the lateral view for an accurate diagnosis. The styloid process of the ulna is frequently broken off in a Colles's fracture. The lower fragment of the radius is displaced backwards. The antero-posterior view frequently shows at the same time a lateral displacement of the lower fragment, usually towards the thumb. Rotation of the separated fragment may also be found by a lateral view. Before the age of twenty a lateral view may show slight displacement through the epiphyseal line, with displacement of the epiphysis backwards ; while an antero-posterior view of the same wrist would show no deformity. In such doubtful cases it is desirable to

have a similar skiagraph of the sound wrist, taken at the same time and in the same position as the injured wrist.

A Colles's fracture can usually be seen by screen examination, but is not always visible. In a doubtful case a plate is necessary for its diagnosis. In doubtful cases, both wrists should be examined with the screen, and skiagraphed together. The scaphoid is frequently fractured along with Colles's fracture.

The **Upper Epiphysis** of the radius is not infrequently separated from the shaft in severe injuries to the elbow-joint. An antero-posterior view shows the fracture ; but its relative position is best obtained by stereoscopic views. If this fracture is not reduced, a great deal of callus appears around the head of the radius.

The head of the radius often has a large chip knocked off. It can be best recognized by stereoscopic views.

Fracture through the Neck of the Radius is easily shown on a skiagraph. The head of the radius is rotated by the biceps, and when union takes place, there is apt to be diminished power of pronation and supination. This can be guarded against during union by watching the position of the bicipital tubercle. The bicipital tubercle shows best in a radiograph, when the radiograph is made with the elbow bent to a right angle, and the hand lies prone on the photographic plate, with the arm and forearm in the plane of the plate, the X-ray tube being placed at right angles to the plate and opposite the head of the radius. When the radius is supinated from this position to 30°, the tubercle gradually disappears, and at 45° is quite lost. At 60° it begins to appear on the outer edge of the radius.

Fracture through the **Shaft of the Radius** is easily diagnosed by X rays, and can be seen by screen examination.

Green-Stick Fracture of the radius is common, and may not be diagnosed by screen examination. A plate, showing antero-posterior and lateral views, is sure to show the condition.

Dislocation between the lower ends of the radius and the ulna can be well seen in antero-posterior and lateral views.

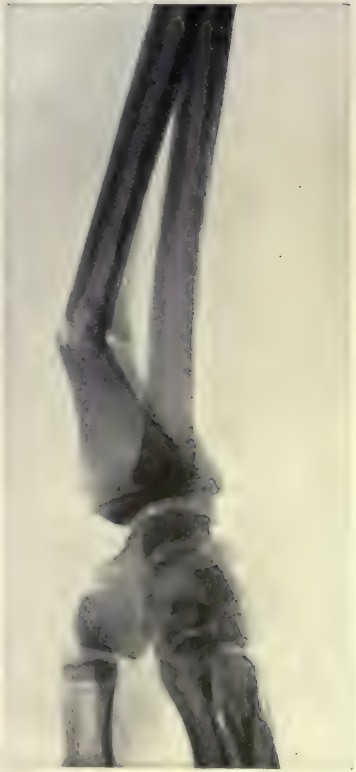
The lower epiphyses of the radius or ulna may be traumatically separated from their respective diaphyses. The lower epiphysis is usually displaced dorsally. An antero-posterior view may not show this condition unless there is great displacement. A lateral view shows it. The displacement may be so slight that one has to compare the injured with the normal to be sure of it.

A dislocation is sometimes thought to be present in a normal wrist when the skiagraph shows a wide separation between the lower end of the ulna and the unciform. There is normally a wide separation in a radiograph, due to the triangular, interarticular fibro-cartilage, which casts no shadow. If the hand is bent to the radial side, there may be a space of nearly an inch.

Dislocation of the Radius at the Elbow-Joint is met with in severe injury at the elbow-joint. A lateral view usually shows the head of the radius lying in front of the lower end of the humerus.

Elbow-Joint.

A good lateral view of the elbow-joint can always be got. A good antero-posterior view is frequently impossible when the patient cannot straighten the joint. When an antero-posterior view is taken in such a flexed position, a blurred result is obtained. Such a blurred picture is,



(Lateral View.)

(Antero-Posterior View.)

FRACTURE OF SHAFT OF RADIUS.

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PLATE VI.

Dislocation of Head of Radius.

Normal Elbow showing Epiphysis.

[To face page 48.

STAGES IN THE REPAIR OF A BADLY-SET FRACTURE AT THE LOWER END OF A CHILD'S HUMERUS.

A useful elbow joint was the final result. The formation of callus is well shown.

[To face page 49.

however, of great value, and though very different from what the surgeon is accustomed to look at, it may teach him more than a good lateral skiagraph of the same elbow. For those who have good stereoscopic vision, a stereoscopic view of the elbow in the lateral position is of still more value. A curved sensitive film may be used to fit a flexed elbow.

When the elbow can be straightened, lateral and antero-posterior views may be as useful as stereoscopic views ; but when the elbow is bent at an angle of from 135° to 90°, stereoscopic lateral views are most useful, as an antero-posterior view is not only blurred, but also distorted. The value of the latter must not, however, be forgotten.

Fracture at the Lower End of the Humerus is one of the commonest injuries discovered by X rays in this region. Fracture takes place just above the lower epiphysis of the humerus, and the lower fragment, along with the elbow-joint, is displaced backwards. When reduction is attempted under an anæsthetic, while watching the result with the screen, it is advisable to remember that too much manipulation only does harm. It may be impossible to get the parts into good position without operating, yet a useful elbow-joint may be got when only a moderately good position of the fragments has been secured.

There is often lateral as well as posterior displacement of the separated epiphysis.

In this fracture either the capitellum, the internal condyle of the humerus, the head of the radius, or the tip of the olecranon, or combinations of these, may be broken off, and complicate the fracture. Small fragments of bone detached from the fractured surfaces may also be seen lying loose near the joint.

Dislocation of the Elbow-Joint is frequently accompanied by separation of a chip of bone from one of the bones of the joint, usually the head of the radius, or by a separation of the lower epiphysis of the of the olecranon may accompany dislocation.

If dislocation occurs with fracture of a part of the lower end of the humerus, the dislocation must be reduced; but if a dislocated appearance is produced, due to fracture through the lower end of the humerus with posterior displacement of the lower fragment, it is not of such importance to reduce the dislocated appearance. In the first instance a stiff joint would result; in the second, moulding of the humerus takes place, and a good joint is got. It is of great importance to get the articular surfaces in contact. If this is done the fracture will unite, and moulding will take place in the humerus, so that redundant bone will be absorbed, and extra bone will be thrown out where required.

An elbow which has been dislocated and remains troublesome may show callus round the joint, or myositis ossificans in surrounding muscles.

Humerus.

Surgical Neck—(*a*) Impacted.—When this fracture is impacted, X rays can show the line of fracture, or at least part of it. Owing to the swelling and effusion of blood, it is sometimes difficult to get a perfectly clear radiograph of this fracture, especially in a stout person.

One can, however, always get a sufficiently clear radiograph for accurate diagnosis. An antero-posterior view is the only practical one. Stereoscopic views are therefore of value. Usually, however, one antero-posterior view will satisfy the surgeon. The impaction is sometimes so complete that the line of fracture hardly appears in

the radiograph, and has to be looked for carefully before it is seen. The radiograph ought to be made in not more than ten seconds, and the patient should hold his breath while it is being made, as otherwise the movement of the chest will blur the result.

(*b*) **Unimpacted.**—The relative position of the fragments can best be shown by stereoscopic photographs.

Fracture of the surgical neck may be accompanied by dislocation at the shoulder-joint. Stereoscopic views are best in such a case.

Fracture of the anatomical neck and separation of a small chip of bone from the head of the humerus are discovered in radiographs.

Fracture of the great tuberosity of the humerus is well shown in an antero-posterior view. It is not usually much displaced, unless complicated by dislocation at the shoulder.

Simple Dislocation at the Shoulder-Joint.—This can usually be shown by an antero-posterior view. The distance between the clavicle and acromion and the head of the humerus varies greatly in different cases, and when it is great is apt to give rise to the impression that there is dislocation. This distance should not be used as a guide for the diagnosis of dislocation. Comparison with the other side should be made if necessary. The real guide should be the relative position of the articular surface of the humerus and the glenoid cavity. An X-ray antero-posterior view may be necessary in some cases for diagnosis. The outline of the glenoid cavity can always be clearly defined in a radiograph of the shoulder-joint. If, in a radiograph, the outer border of the shaft of the humerus be prolonged upwards in a normal joint, it will not meet the clavicle; but when there is dislocation at the shoulder-joint, this line will meet the clavicle. When the surgical neck of the humerus is fractured, this rule may not hold good.

Before the junction of the head and the shaft, the head caps the shaft like a ball and socket, therefore the epiphyseal line does not appear in a radiograph as a straight line, but more as an ellipse, in which the head overlaps the epiphyseal line.

Scapula.

Fracture of the body of the scapula may occur. The want of continuity in the axillary or vertebral border may be the only indication of the fracture, as the body of the scapula is so thin it casts very little shadow. The fracture is usually about 1 inch from the lower border of the glenoid cavity. In skiagraphs of the shoulder-joint, when the plate has been placed on the front of the chest, the coracoid appears in the negative with a light outline more or less like a circle. This is due to the neck of the coracoid being denser at its periphery than at its centre, so that it casts a shadow like a hollow tube seen endwise. This appearance must not be mistaken for fracture. A chip of bone may be found detached from the acromion or coracoid in cases of injury to the shoulder, and may explain why some injuries to the shoulder remain painful so long. A distorted picture of the scapula can be made, in which the upper angle of the scapula appears very much too long.

Fractured Coracoid may be suspected from an antero-posterior view; but stereoscopic radiographs are essential for an accurate diagnosis. The relative position of the coracoid to the surrounding bones varies very much according to the position of the X-ray tube when

the skiagraph was made. If the tube is placed towards the opposite side of the body, the tip of the coracoid overlaps the shoulder-joint in the radiograph. If the tube is placed towards the middle of the back, the coracoid is projected upwards clear of the upper border of the scapula. Great care must therefore be used in diagnosing fractured coracoid by its relation to the surrounding bones. It is rarely found in a skiagraph.

The **Acromion** may be fractured at its free extremity, and the detached fragment may be seen lying above the upper and outer part of the head of the humerus. The tip of the acromion is formed from a separate centre of ossification, which joins at about twenty years of age.

Clavicle.

The radiograph should have been made while the patient held his breath, and the plate should have been placed next the front of the chest. Under these conditions a fractured clavicle can be easily shown. It is seen fairly often in babies, in whom an anæsthetic may be required in order to get a clear skiagraph. An antero-posterior position is the only practical one in which to take the clavicle.

A small chip of bone is not infrequently knocked off the extremity of the clavicle, and may be all that a radiograph shows in a case of severe injury to the shoulder-joint.

Dislocation at the sternal end of the clavicle is easily shown.

Acromio-clavicular dislocation is seen in an antero-posterior view. There is normally a space between the acromion and clavicle which may amount to ¼ inch. When this distance is exceeded, dislocation may be suspected, and when it amounts to ½ inch or more, it warrants a diagnosis of dislocation. Stereoscopic radiographs should be made when there is doubt, and the normal side compared with the other. A large plate may be used, on which both shoulders are shown with the X-ray tube placed opposite the middle line.

INJURIES TO THE BONES OF THE LOWER EXTREMITY.

The Foot.

Phalanges.—Screen examination may not show a fractured phalanx, especially when comminuted, while a radiograph shows it. An antero-posterior view is sufficient to show a fracture of a phalanx. A fairly lateral view may also be had by judicious manipulation so as to avoid superposition of the bones.

X rays are useful for showing many different conditions in the phalanges and metatarsals, among which the following are common: Fracture, dislocation, stumps, exostosis, deformities, hallux valgus before and after operation, presence of sesamoid bones, foreign bodies, outline of tumours, gout, monstrosities, and bone diseases.

Metatarsals.—They should be examined by antero-posterior and semilateral views. In a true lateral view the bones are superimposed, but still it may be of value. Stereoscopic views are good for showing the amount of displacement in this fracture. Comparison should be made with the sound foot.

Tarsus.—Dislocation and fracture of the tarsal bones are best shown by stereoscopic views taken in a half-lateral position. The antero-posterior view is also useful for all the tarsal bones. The os calcis and the astragalus are seen more clearly in a lateral view.

The **Os Calcis** is the most frequently fractured bone of the tarsus. This fracture may be accompanied by fracture of other tarsal bones. The fracture may not be visible by screen examination, but is disclosed by a skiagraph. The line of a fracture is frequently at right angles to the long axis of the bone, and may be in the anterior or posterior portion of the bone. The upper part of the os calcis may be found impacted into the lower part.

The **Astragalus** may be fractured through its neck. A lateral radiograph will show the condition. The displacement in fracture of the os calcis and of the astragalus is not usually great. The os trigonum (the outer posterior tubercle) must not be mistaken for a fractured astragalus. The presence of possible sesamoid bones and of osteo-arthritis should be kept in mind.

The **Scaphoid** when fractured is best seen in an antero-posterior view. It presents most frequently a comminuted fracture. Dislocation at the astragalo-scaphoid joint shows in an antero-posterior view, when there is lateral displacement.

The other tarsal bones are not often fractured.

A **sesamoid** bone often lies external to the cuboid, and must not be diagnosed as fractured cuboid. One or two are frequently found under the head of the first metatarsal. Rarely one lies under the head of the fifth metatarsal.

The Leg.

Fractures of the bones of the leg are so numerous and different in appearance that it is rare to get two skiagraphs of different patients which appear alike. An antero-posterior and lateral view will show them all satisfactorily.

The **Tibia** should always be examined by antero-posterior and lateral views.

Fracture of the Shaft presents no difficulty in diagnosis. Comminuted fracture is commonly found in the tibia.

A green-stick fracture is not uncommon, and may not be visible by screen examination.

The Lower End.—The styloid process of the tibia is frequently detached in cases of Pott's fracture, and is best seen by an antero-posterior view. In a lateral view the overlapping of the lower end of the fibula over the lower end of the tibia gives rise to an appearance somewhat like fracture. By following the edges of the tibia and fibula in cases of fracture, a radiograph shows a break in the continuity, whereas in overlapping without fracture there is no break in the continuity.

Fracture of Both Bones should be examined by an antero-posterior and a lateral view, in order to be sure of the exact amount of displacement. Detached fragments of bone are not uncommonly seen.

The Fibula.—Fracture near the head may occur when the shaft of the tibia is fractured towards its lower end. It can be seen by screen examination, and ought to be looked for.

Fracture of the Shaft of the Fibula is easily diagnosed.

Pott's Fracture is best seen by an antero-posterior view, but it should also be examined laterally. In simple cases there is little displacement.

PLATE VIII.

FRACTURED PATELLA.

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In severe cases there is considerable displacement of the lower fragment, and the styloid process of the tibia is frequently fractured as well. The tibia and fibula may be dislocated forwards at the ankle, complicating the fracture. A posterior metal splint should be avoided if a radiograph is required. All fractures of tibia and fibula can be sufficiently shown with wooden splints in position. A lateral view may show forward dislocation of the tibia and fibula. An antero-posterior view may show the astragalus wedged between the tibia and fibula, but this is rare.

The Knee.

Patella.—Fracture of the patella should be examined by lateral and antero-posterior views. Usually the patella breaks into two pieces, but occasionally it is broken into several pieces (see Plate VIII.). An antero-posterior view will show the various pieces. After wiring the pieces, a radiograph shows the result to perfection. Sufficiently stout wire should be used, as radiographs have shown that the wire in many cases has given way because it was too weak. A splinter knocked off from any bone in the region of the knee-joint should be examined stereoscopically. Sesamoid bones, which are common in the tendons behind the knee-joint, must not be diagnosed as fractured pieces of bone, nor as foreign or loose bodies. In an antero-posterior view the patella lies over the femur. Its position is higher up on the femur than most people expect to find it.

Displaced semilunar cartilages are transparent to X rays, and therefore do not appear. It is possible to show them in a radiograph when they are calcified.

Fracture of the **upper end of the tibia** is not common. A fragment may be detached, and can be seen stereoscopically. The whole or part of the tubercle of the tibia may be detached from the bone. A lateral view shows it. The condition may persist many years after the injury.

Fracture of the **head of the fibula** may occur, and can be shown in an antero-posterior view. Fracture occurring an inch or two from the head may be found when the tibia is fractured low down.

Femur.—Fracture of the **lower end of the femur** is easily shown by antero-posterior and lateral skiagraphs. When the knee has to be kept bent, lateral stereoscopic pictures should be made.

Fracture of the **shaft of the femur** should be examined by antero-posterior and lateral views. When well set, the ends of the bone lie side by side. Only after operation with plating do the bones lie end to end. A comminuted fracture should be examined by X rays after reduction to see that the best position has been obtained.

Hip-Joint.

Antero-posterior and stereoscopic views are the more practical ones for this joint. A lateral view can be obtained by proper manipulation. The plate should have been placed on the front of the joint, and the patient's heels and toes should have been touching while the radiograph was being taken. Under these conditions a true antero-posterior view is got of the neck of the femur. If the feet are everted when the radiograph is being made, the neck of the femur is much shortened, and might give one the impression that absorption of the neck had taken place. Fractures are usually seen through the neck

or just below the great trochanter. Comminuted fractures also occur about the neck, and are best diagnosed stereoscopically. Extracapsular and intracapsular fractures can be diagnosed by a radiograph.

Right and left hip-joints should be shown on the same plate. In adults the skiagram of the two hip-joints should have been made by separate exposures, with the X-ray tube centred opposite each joint. In fat patients with pendulous belly it is difficult sometimes to get a good radiograph of the hip-joint.

Congenital dislocation is well shown by X rays, and stereoscopically one can determine the condition of the head of the femur and the depth of the acetabulum. An opinion as to the possibility of Lorenz's operation doing any good should thus be formed from stereoscopic views. If there is no acetabulum to put the head of the bone into, or if there is no real head on the femur, it is of no use to operate. Both hip-joints should be shown on the same plate and taken at the same exposure. Double congenital dislocation is frequently found. A stereoscopic view may show a new acetabulum formed in the ilium for the head of the femur. It may appear to be too low down for the head of the femur when the head of the femur is cartilaginous, because cartilage does not, as a rule, show in a skiagraph of a hip-joint.

After operation it is possible to get a skiagraph of the joint through the plaster of Paris dressing, but the thicker the plaster of Paris the less distinct will be the outline of the bone. It usually shows that the great trochanter is the part of the femur nearest to the acetabulum, or that the femur has an imperfect head pointing at the acetabulum.

Fracture of the **great trochanter** is sometimes diagnosed in patients under eighteen years of age when none exists, due to the ununited epiphysis. When the great trochanter is fractured, it is frequently comminuted. In an *old impacted fracture of the neck* of the femur so much callus may have formed that it may give rise to the appearance of a tumour.

In a newly **impacted fracture of the neck** the line of fracture is indicated by an irregularity at the edge of the bone, the shortening of the neck, its shape and angle. There is no visible line of fracture through the bone, as usually seen in a negative of an unimpacted bone. The intertrochanteric line normally casts a shadow, which must not be mistaken for a fracture.

In a normal joint the line of the lower border of the neck of the femur and the upper border of the obturator foramen form an arch (Shenton's arch). This line is broken in dislocation and fracture of the neck of the femur.

Coxa vara is easily shown by X rays, but the joint of the other side should always be used for comparison.

Slipped Epiphysis.—An antero-posterior view shows this condition. The displacement is not usually more than $\frac{1}{4}$ inch.

Dislocation of the hip appears to be usually upwards in an antero-posterior skiagraph.

The head of the femur in old-standing cases of dislocation is usually abnormal in shape.

PLATE IX.

SARCOMA OF THE LOWER END OF RADIUS.

(*Archives of the Roentgen Ray*, June, 1909.)

[To face page 55.

PLATE X.

MULTIPLE ENCHONDROMATA.

[To face page 55.

DISEASES OF BONES AND JOINTS.

Monstrosities.—The variety of monstrosities met with is so great that a detailed description does not come within the scope of this work. Supernumerary digits, union of bones, want of bones, unusual position, longer or shorter bones, etc., are frequently met with. Each case should be dealt with according to the condition disclosed by an antero-posterior, and, if necessary, a lateral, skiagraph.

Periostitis increases the diameter of a long bone. The original shaft of the bone, or parts of it, can be made out indistinctly inside the general thickening. The new bone is less dense than normal bone, and does not show such fine detail. A sequestrum in a negative appears as a lighter patch inside the bone, while a sinus appears as a black spot, provided the X rays happen to have shone through the sinus in the proper direction. Periostitis may be limited to a small area. It forms a swelling with an irregular edge in a skiagraph.

Osteitis causes local thickening of the parts affected. Parts of the bone may remain normal. The original shaft of the bone cannot usually be made out as in periostitis. The outline of the bone becomes irregular in advanced cases. The enlargement is fusiform.

A new growth arising from bone may cause local overgrowth of the bone with detached or semi-detached pieces, which are easily seen in a negative. Or there may be eating away of the bone, and the bone appears in the negative as if it had been gnawed away locally.

Spontaneous fracture may be shown in a new growth when so gnawed away.

Periosteal Sarcoma gives a gnawed-away appearance to the bone, with swelling of soft parts, and bony remnants in the swelling. It is localized to one part of the bone, and does not go all round, as callus does. **Medullary Sarcoma** expands the bone, and gives rise to a tennis-racquet appearance—*i.e.*, an expanded portion corresponding to the growth, with irregularly-placed trabeculæ of bone forming a network. The fibula, the head of the humerus, and the lower end of the femur, are the most frequent sites of medullary sarcoma.

Benign Cystic Growths of the phalanges show in a skiagraph rarefaction of the bones in a circumscribed area, with a localized swelling of the bone and a mottled appearance over the swollen area. It arises in the shaft at its periphery. An abscess in a phalanx resembles a cystic growth, but the abscess is central, and has a dense periphery and a rarefied centre.

Epiphysitis gives the epiphysis a swollen, indistinct appearance, with partial obliteration of the epiphyseal line.

Enchondroma resembles a benign cystic growth in appearance. Enchondromata may affect nearly all the phalanges and metacarpals at once.

Exostosis of a long bone is clearly seen in a negative when the exostosis is made to appear at the margin of the bone. It presents the appearance of perfect bony structure. An exostosis is thus distinguished from a malignant growth containing bone, for in the latter the texture of the bone is irregular. An exostosis has frequently a narrow base, while a new growth has a broad one. When an exostosis from one bone presses on another bone, it causes erosion of the bone pressed on. Multiple exostoses are not uncommon, especially around the knee-joint.

Abscess in the End of a Long Bone starts in the diaphysis near the epiphyseal line, and extends towards the middle of the shaft. It is characterized in a negative by a clear, defined dark patch surrounded by a light border. The detail of the structure of the bone shows distinctly in the position of the abscess.

Dactylitis of septic origin usually affects the terminal phalanx, and gives it an eaten-away appearance. Tuberculous dactylitis may affect any phalanx, and give rise to the same appearance.

Coxa Vara is clearly shown in an antero-posterior view. It is essential that both hip-joints be shown on the same plate, having been taken at the same time, and that the feet were bound together with the toes pointing forwards when the skiagraph was made.

Genu Valgum is well shown by antero-posterior views. The same is true in **Genu Varum**.

Gonorrhœal Arthritis may very closely resemble tuberculous disease, and, apart from the clinical history, it may be impossible to diagnose between the two by X rays.

Tuberculous Disease of a Joint, when well marked, gives an appearance in a radiograph not unlike that of a normal joint which has been moved a little while the skiagraph was being taken. The individual bones have irregular margins, and are less opaque to X ray than normal. The affected bones appear "fuzzy." The bones adjoining the diseased joint present a "pencilled"* appearance at their edges. The details in the neighbouring unaffected bones is specially well shown when only one bone is diseased. In an early case the diseased bone may have a margin which looks as if it had been gnawed away, and the whole bone is less opaque to X rays. The right and left joint should be taken together at the same time on the same plate, and the differences are then evident between the normal and the abnormal.

A **tuberculous hip-joint** is characteristic in a radiograph. An early case in which the synovial membrane is affected and the bone not eroded shows less density in the shadow of the bone. This can only be seen by comparing the two sides.

When, later on, the bone is eroded, the erosion may be shown by a radiograph.

In a well-marked case the arch (as seen in a radiograph) formed by the lower border of the neck of the femur and the upper border of the obturator foramen is broken, because the femur is drawn upwards. The density of the bone is lessened, and the outline of the head may be indistinct. The neck may be broader on the affected side. A small eroded piece of bone may be found loose in the joint. In old, quiescent cases absorption is shown of the acetabulum, and of the head and neck of the femur.

Tuberculous Disease in the Spine shows in a radiograph when the bone is affected, but disease of the cartilage does not appear. The body of the vertebra is the part which first shows changes in a radiograph. In an early case the body is rarefied, and has a gnawed appearance. In a well-advanced case the body becomes crushed between its neighbours. This condition can be seen in the cervical and lumbar regions in antero-posterior and lateral views. In the dorsal region a lateral view may be the only one which shows the condition.

* "Pencilling" is the term applied to the appearance seen in a negative when the edges of the bones are extra clearly defined, as if a photographer had sharpened up the edges of the bone with a retouching pencil. The appearance is due to disuse atrophy, and is found whenever the bones are not used, whether due to accident or disease.

EXOSTOSIS (FRACTURED).

BRODIE ABSCESS IN TIBIA.

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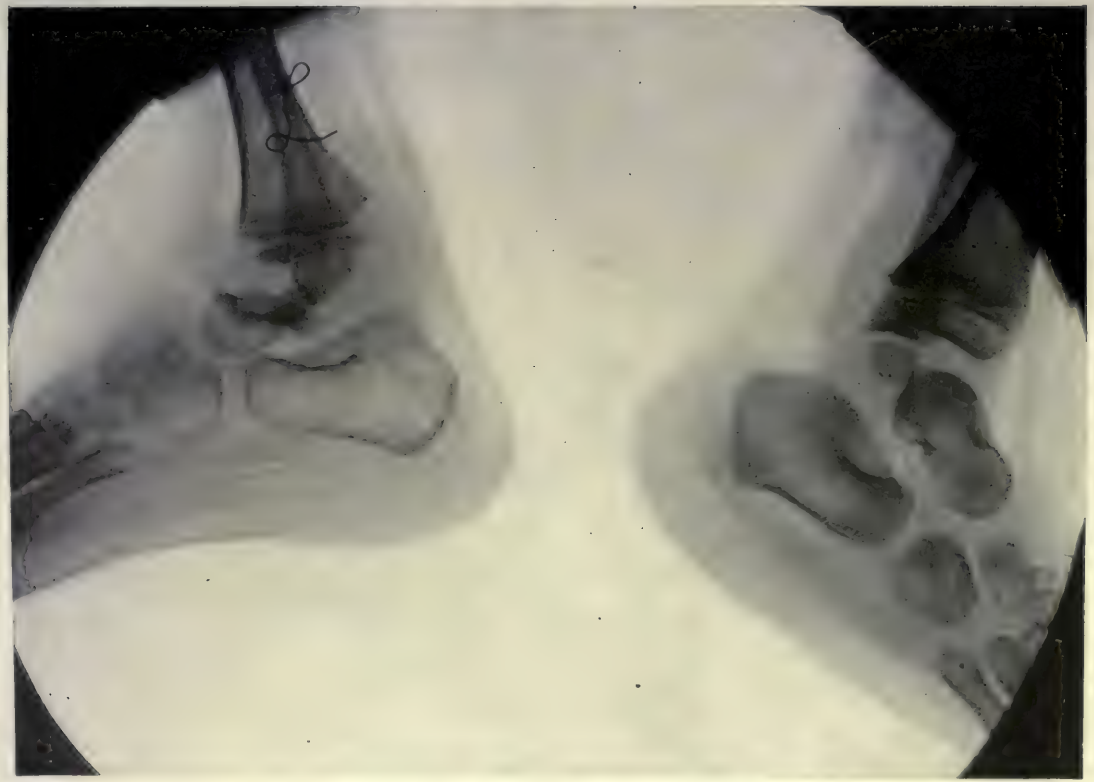

TUBERCULOUS DISEASE OF ASTRAGALUS.

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Spina bifida shows best in a lateral view.

Syphilis affecting a long bone causes general thickening of the bone without leaving so clear an indication of the original shape of the bone as is seen in periostitis. The outline of the bone may grow wavy. When localized it simulates sarcoma, but it does not show coarse trabecular bony detail as is seen in sarcoma affecting the bone. It causes broadening of the phalanges and metacarpals, and affects their shafts more than their extremities. The same appearance is got in pulmonary osteo-arthropathy. Clubbed fingers found in advanced phthisis show no change in the terminal phalanges.

Gumma may affect the periosteum, and give rise to a characteristic appearance in the negative. When seen in a lateral view there is a swelling which is on the edge of the bone, and has a very indistinct edge, gradually shading into the soft parts with no line of demarcation. The swelling has no detail in it, thus differing from a sarcoma. Gummatous erosions of the frontal bone appear in a negative as light areas best seen in a lateral view.

Rheumatoid Arthritis shows in a radiograph diminution of the normal space between adjacent bones. The bones may even appear to be in contact, due to the absorption of the articular cartilage. The normal joint of the opposite side should be used for comparison. In later cases characteristic deformities are visible in the radiograph—*e.g.*, the ulnar deflection of the fingers. Osteophytes are not common, but when they occur they are small, and limited to the epiphyses. In early tuberculous disease of a joint there is no narrowing of the joint spaces, and no formation of osteophytes.

Osteo-arthritis shows in a radiograph less reduction of the normal spaces between the bones than is seen in rheumatoid arthritis. In the foot one may find complete dislocation of several of the metatarso-phalangeal joints. These are frequently symmetrical. Osteophytes occur on the epiphyses, and also on the diaphyses. Parts of the bones show increased density, and pencilling occurs. Rarefaction of cancellous tissue occurs both in osteo-arthritis and in rheumatoid arthritis. The degree of rarefaction depends on how much the patient has used the joint rather than on the disease. It is really a disuse atrophy.

Rickets.—In old-standing cases the deformity of the bones can be well shown in a radiograph. The internal structure of the bone appears normal, and shows much detail. It is frequently difficult to get rickety children to lie still, so that the fine detail may be lost in a radiograph if the child has moved. The cortex of the bone is increased in density when there are unnatural curves. The increase is especially marked on the concave surface.

The epiphyseal lines are wider and more irregular than normal. The epiphyseal end of the diaphysis is more expanded in relation to the epiphysis than normal, and may have a ragged appearance. Ossific centres appear late. Fracture is followed by poor callus formation.

Myositis Ossificans appears in a radiograph as a thin sheet or needle of bone running in the direction of the bone to which it is attached. It is less dense than the normal bone, and has an indistinct faint edge. It may appear near the elbow-joint after an injury, and then casts a blurred shadow of the same density as callus, but it is much more abundant than callus, and is not in close contact with a fracture.

Acromegaly.—In acromegaly the bones of the hands are enlarged in every direction, and the outline of the bones is irregular, especially

the terminal phalanges, which may have small exostoses. The sesamoid bones at the base of the thumb may be specially enlarged. The sella turcica can be readily seen in a radiograph of the skull, and may be found enlarged in this disease. The bones of the skull are also thickened, and there is increase in the depth of the frontal sinuses when seen in a lateral view.

Gout in the Hand causes disintegration of the joint. Advanced gout in the fingers gives a mottled, ground-up appearance of the bone, as if the bones had been ground in a mortar. It affects the ends of the bones principally. The distant bones are rarefied, and their outlines have a "pencilled" appearance.

Osteitis Deformans shows in a negative a very expanded bone, a laminated appearance at the periphery, with a very dense shell of bone, and a central part showing a network appearance, with meshes at right angles.

In **Osteomalacia** the density of the bone is lessened, due to absorption of lime salts. There may be a "pencilled" outline, with irregular thickening. The diameter of the bone may be decreased. Fine detail of spongy tissue disappears, and irregular, rarefied spots appear. A ladder pattern is frequently seen at the lower end of an adolescent normal tibia; exaggeration of the same appearance may be seen in osteomalacia. Fractures may be found in this disease, and callus formation following is poor.

An **Ankylosed Joint,** due to bony union, is characteristic in a negative. The cementing bone is less dense than the normal bone, and has an irregular, patchy, and streaky appearance.

Chondrodystrophia Fœtalis (achondroplasia) is characterized in a radiograph by shortening and broadening of the long bones, increase of the cortex, and lateral expansion of the epiphyseal ends of the diaphyses. The epiphyses are also broadened.

Fragilitas Ossium is characterized by multiple fractures in young subjects and slight imperfections in the development of the bones. Callus, as shown in a radiograph, is abundant.

In **Scurvy** hæmorrhage occurs under the periosteum, and gives a double contour to a long bone. It may be localized, or extend the whole length of the bone.

THERAPEUTIC USES OF X RAYS IN SURGICAL AFFECTIONS.

In small doses X rays act as a stimulant, in larger doses as a vesicant, and in still larger doses as a destructant. They differ from other agents which act in the same way—*e.g.*, iodine—by their property of acting on the surface and on deep tissue at the same time. This is due to the power of penetration of the rays, and the absorption of them which goes on at successive layers of tissue. As a general rule young cells are more easily destroyed than old cells, and it is the young cells which are the most easily killed by X rays. These are found most abundant at the roots of the hairs, in all active glands, and in new growths. Small doses of X rays stimulate these cells, and larger doses kill them. Therefore small doses of X rays increase the growth of hair and new growths, and large doses kill the same things. This is the principle on which is based the use of X rays for therapeutics.

PLATE XIII.

LUPUS BEFORE X-RAY TREATMENT.

LUPUS AFTER X-RAY TREATMENT.

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PLATE XIV.

RODENT ULCER BEFORE X-RAY TREATMENT.

RODENT ULCER AFTER X-RAY TREATMENT.

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Measurement of the Dose of X Rays.—X rays cannot be detected by sight, sound, taste, smell, or feeling. The human skin shows the effects of a sufficient dose of the rays from ten to twenty-one days after the rays have fallen on it. The measurement of the rays is made in units. The unit of measurement is known as an " epilation dose," or a " normal dose," or as a " one-pastille dose." In Germany it is called a " 10 X " or " 5 H." It is this dose which makes the hair fall out of a child's scalp three weeks after the dose was applied without causing any redness of the skin, and the hair begins to grow again six to eight weeks after epilation has taken place. This is a very definite dose. A smaller dose will not cause epilation, and a larger dose will produce permanent epilation. The dose is measured by a pastille of barium platinocyanide, which changes from a lemon yellow to an orange colour while a pastille dose is applied. The pastille must be used with many precautions. As a pastille dose can be applied in from thirty seconds to three hours, it is no measurement of the dose of X rays to say that " the patient was exposed for ten minutes." When more than a pastille dose is applied to the skin, the skin grows red in from ten to twenty-one days. If the redness appears after three weeks, no serious result will follow; but if it appears before ten days, the dose applied must have been a large one, and an X-ray burn may follow.

After one pastille dose has been given to normal skin, an interval of two to three weeks should elapse before another pastille dose is given.

Lupus Vulgaris.—Repeated small doses of X rays make the tubercles more visible. They swell up, and are shed forth, leaving small depressed scars. New tubercles are brought into evidence, and they go through the same process. The curative results are as satisfactory as those produced by Finsen light. If the rays are used for a long period (say six months), telangiectasis may follow several months after the treatment has been stopped. No telangiectasis follows Finsen treatment. Some cases of lupus do not respond to X-ray treatment, and had best be treated by other means. The scar left when lupus is cured by X rays is soft and pliable.

Nævus has been cured by X rays, but it is better to treat it by other means. The rapid growth of large nævoid tumours is stopped by an epilation dose of X rays.

Hypertrichosis on a woman's face is best treated by electrolysis. The hairs can be made to fall out by X rays, but they grow again after two months unless further treatment is applied.

Malignant Disease.

Rodent Ulcer is very satisfactorily treated by means of X rays. Large doses should be given. Usually an ulcer the size of a shilling is healed in three to four months. When the ulcer has healed, it should be treated once a month with a normal dose of X rays till twelve treatments have been given. If this is not done, the ulcer frequently breaks down within five months of stopping the rays. When it has healed and broken down again, it heals again with great difficulty. Radium should be tried after a relapse.

Carcinoma.—When a carcinoma is removable by surgical means, it should be so removed. When it is beyond the power of surgery to remove it, X rays and radium should be used. The selective action of X rays on young growing cells must be kept in mind in carrying out

X-ray treatment of carcinoma. The most suitable case for its use is after removal of a breast when secondary nodules appear in and around the scar. These secondary nodules disappear under efficient X-ray treatment, and the patient may thus be cured, or at least her life may be prolonged. Large doses of X rays and long intervals, rather than short, frequently repeated applications should be given. The former method kills the young malignant cells, while the latter may stimulate them to increased activity. After operation, if the surgeon does not feel sure that he has removed all the carcinoma, he should indicate to the radiologist where to apply the rays. The scar should be healed before large doses of X rays are given. Successful treatment is frequently accompanied by brown pigmentation of the skin.

Deep-lying carcinomatous growths cannot be efficiently treated by X rays, as the overlying skin would be killed by the rays before the deep-lying tissue received enough rays to kill the malignant cells. These cells, at a depth of 1 to 2 centimetres, can be acted on efficiently by X rays, but beyond that depth it is doubtful if X rays do any good. In the treatment of secondary carcinoma by X rays the results obtained depend largely on the technique used to accomplish the cure. Large, deep carcinoma, which is irremovable, is also beyond the power of X rays.

Sarcoma.—What has been said of carcinoma is also true of sarcoma.

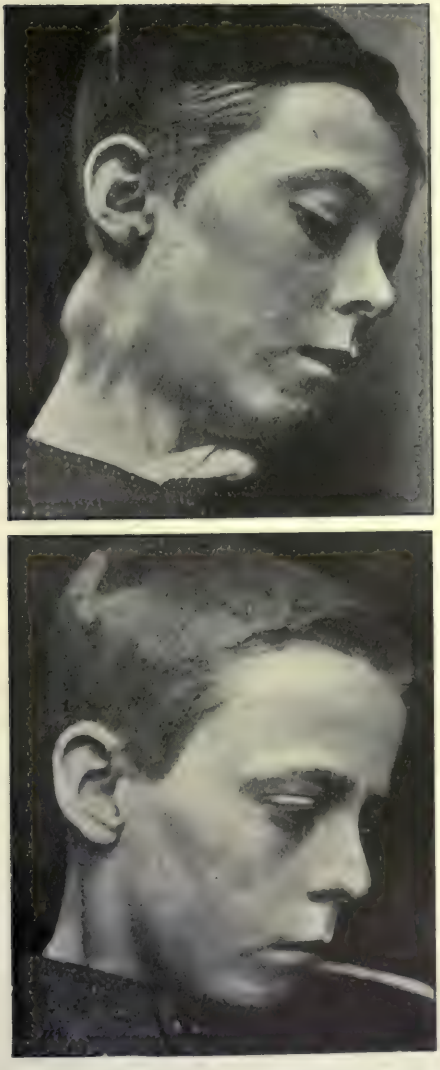
Tuberculous Disease.—Tuberculous glands and joints treated by X rays have frequently improved or returned to normal, but the exact action of the rays in such cases is a matter which is still *sub judice*. If the treatment is pushed to produce redness of the skin, or if it is carried on too long, telangiectasis will follow.

Keloid.—Keloid, growing in a scar, or idiopathic keloid, yields to X-ray treatment. The treatment should be by small repeated doses once a week or fortnight for a period of six to twelve months. The keloid slowly disappears. Only the stimulating effects of the rays are required.

Exophthalmic Goitre has been successfully treated by X rays. The symptoms disappear to a greater or less extent, but the exophthalmos remains. Proper X-ray technique is most important in carrying out the treatment. Too energetic treatment has produced slight myxœdema.

X-Ray Dermatitis may be acute or chronic. The acute form follows too large a dose given at one or more sittings. If one large dose is given—for instance, twice as much as is required to cause epilation—an erythema may appear within a few hours, and after lasting for a day or two disappear. From ten days to three weeks after the application the real dermatitis comes out. The skin grows red, feels hot, and there is intense irritation and discomfort; the hairs come out, and the sweat-glands cease to act. The condition goes on getting worse for a week, then reaches its height, and gradually subsides. Pigmentation follows. If the dose is more severe, vesication or even ulceration is caused. The longer the reaction is in appearing after the application of the rays, the less will the dermatitis be. For instance, if it appears after three weeks, no fear need be entertained that it will go on to ulceration. But if it appears in seven to ten days, a severe dermatitis may be looked for. Its severity cannot be determined till a week or more later. On the palm of the hand a dry blister forms.

PLATE XV.



Tuberculous Glands in the Neck: Before and after X-Ray Treatment.

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PLATE XVI.

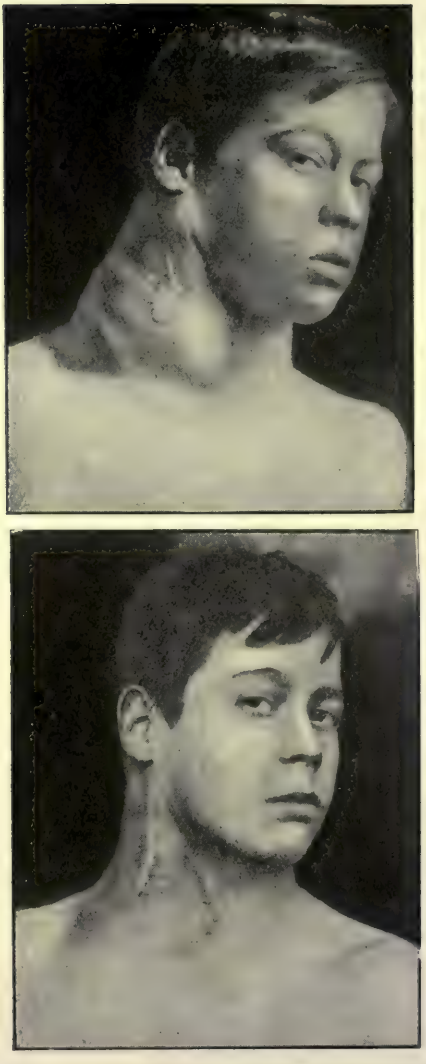
KELOID BEFORE X-RAY TREATMENT.

KELOID AFTER TREATMENT.

(St. Bartholomew's Hospital Reports, vol. xliv, 1908.)

[To face page 60.

PLATE XVII.



LYMPHADENOMA BEFORE AND AFTER X-RAY TREATMENT.

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A severe X-ray burn may go down to the bone, and may take years to heal, or may never heal, and develop into epithelioma

The *chronic form* is found in X-ray workers, and affects principally the backs of the fingers. The nails grow brittle, and ridges appear on them, and later on furrows. Inflammation of the nail follows, and it may drop off. The skin grows chapped, and itching occurs. Later on the skin becomes dry and hard, and warty growths form, from which serum exudes. Ulcerated spots appear, and the underlying bone may grow affected. After continuing for years, epithelioma develops in the warts.

Prevention of X-Ray Dermatitis.—The chief safeguard to the operator is to keep at a distance from the X-ray tube. A distance of 3 yards is in most cases quite safe. The X-ray tube should be enclosed in a lead rubber-lined box, in which a hole is cut for the rays to fall on the patient, and on no other place. Protection of the patient is not usually necessary, as the examination lasts so short a time that he suffers no inconvenience.

Treatment by X rays should be administered by experienced operators only, otherwise the patient runs a great risk. The same is true of screen examinations and the making of X-ray photographs.

Treatment of acute X-ray dermatitis is similar to that of a burn. The heat and irritation should be treated by ice compresses, zinc oxide ointment, or lead and opium lotion. Powerful antiseptics and anæsthetic drugs should be avoided. Rest and non-irritation should be the guiding principle in treatment along with no more X rays.

For the chronic form rest and non-irritation are mainly indicated; splints to the fingers, dry sterile gauze dressing, and avoidance of X rays should be carried out. Warts should be filed flat with sand-paper to prevent their being knocked. Some have been entirely removed by the application of solid CO_2. The dry leathery skin should be softened by lanoline, applied at night.

Sterility is easily produced by X rays. The spermatogenic cells are killed, but sexual power remains unaltered. The ovaries are deeply placed, and are therefore little affected by X rays, but cessation of menses by appropriate treatment can be brought about.

Lymphadenoma is influenced in a surprising manner by X rays. Masses of glands rapidly diminish, and may even disappear under X-ray treatment. The glands in the thorax cannot be reached by the rays, and the patient may die from these or other causes.

The action of the rays is entirely local, and the glands tend to enlarge when the action of the rays passes off. Sea-air should be avoided for lymphadenoma. The decrease in the size of the glands should begin about a month after the first application of the rays.

Fibroid Tumours in the Uterus.—By the action of X rays in bringing on the climacteric period, fibroid tumours have been favourably influenced. Long and careful treatment is necessary.

Intramural and subserous fibroids are suitable for X-ray treatment. Submucous fibroids should be removed by surgery. The patient should be above forty years of age.

CHAPTER V

ANÆSTHETICS AND THEIR ADMINISTRATION

Introduction—Anæsthetics in common use—Stages of anæsthesia—Depth of anæsthesia—Choice of an anæsthetic—Intratracheal administration—Preparation of the patient—The administration—Intravenous anæsthesia—Pseudo-anæsthesia—Difficulties and dangers—Death under anæsthetics—Spinal anæsthesia—Local anæsthetics.

THE medical student, until within recent years, received little or no instruction in the theory and practice of anæsthetics, for although some examining bodies demand a certificate of instruction in, and knowledge of, this subject, other Boards have, up to the present, failed to include this important branch of work in their curricula. With an Anæsthetics Bill in view it would seem that this old order of things will be changed, and that some knowledge of anæsthetics must be obtained before the final examination can be passed.

To obtain the best practical results in anæsthetizing a patient, the student is advised to make himself acquainted with the different anæsthetics. The man who employs one to the exclusion of all others cannot fail to meet with much more trouble than he who can use a series. A troublesome, or even a difficult, case may generally be safely conducted by employing two or more anæsthetics either in mixture or in sequence.

The most frequently used anæsthetics are chloroform, ether, ethyl chloride, and nitrous oxide, alone or mixed with oxygen, and these only will be considered. The student will find mention made of various mixtures and sequences throughout the chapter.

Stages.—For clinical purposes four stages or degrees are usually spoken of with regard to the action of anæsthetics :

1. **Stimulating.**
2. **Narcotic.**
3. **Anæsthetic.**
4. **Paralytic.**

There can be no defined line drawn between these stages, which gradually merge into one another during an administration. They also vary in duration with different patients and with different anæsthetics. For instance, the stimulating stage with nitrous oxide or ethyl chloride is very brief as compared with that of chloroform.

1. The **stimulating** stage shows itself, as its name implies, by stimulating the functions. In a patient free from nervousness, the pulse is found to increase in force and frequency, the respirations (if cough, holding the breath, or other irritative or emotional effects are not produced) become deeper and quicker ; ringing in the ears, flashes

of light, etc., may be complained of; buccal or other secretions are stimulated, and increased mental activity shows itself. Reflexes are all present. The patient is conscious during this stage, being able to converse more or less rationally, and being aware of pain if inflicted. This consciousness becomes more and more distorted, and gradually diminishes until entirely lost in—

2. The **narcotic** stage, in which consciousness to pain is lost, and in which struggling (especially in alcoholics), talking, singing, crying, etc., may develop. The reflexes disappear one by one—the coarser going first, and the more delicate later. The reflexes do not disappear in different patients in the same order. The cutaneous sensibility in some goes early, but usually it is more persistent. In the eye the light or pupil reflex may be lost before the scleral, although it is not usually so, and in a few cases it is found to persist after the *corneal* reflex has disappeared. As one by one the delicate reflexes are abolished—

3. The **anæsthetic** stage is entered, in which the patient is absolutely unconscious; the pupil is generally contracted and fixed; breathing is regular and automatic, that with ether usually being louder or more stertorous than that with chloroform; and all reflexes are lost, with the exception of one or two—*e.g.*, I have found that the solar reflex (obtained by the surgeon pulling upon the solar plexus during an abdominal operation) may persist on the border of the paralytic stage, and Sir William McEwen has recorded that he has obtained the pudic reflex in the deepest anæsthesia. The cardiac and respiratory centres in the bulb remain active. If the administration is pushed further—

4. The **paralytic** stage is reached, and death results from paralysis of respiration and of the heart, respiration in the vast majority of cases—in fact, in practically every case—failing before the heart. "Absence of a wrist pulse by no means indicates that the heart has ceased to beat" (Hewitt).

Depth of Anæsthesia.—No two cases are exactly alike, and a single sentence cannot answer—

"At what depth must anæsthesia be maintained?"

Yet certain conditions may serve as guides, though they must not be taken as rules. It is a mistake to think that the third, or anæsthetic, stage must be produced and maintained throughout an operation. A milder degree of narcosis will suffice in many cases, which has been pointed out as a necessity in the skilful administration of an anæsthetic, for the **administrator** (I purposely avoid the title **anæsthetist** here) who unnecessarily keeps his patient in the anæsthetic stage during the whole of an operation largely increases the risk to life, and may endanger or lengthen the patient's convalescence. Many procedures demand profound anæsthesia—*e.g.*:

When the operation is of a very painful character, as in avulsion of a nail, operation upon certain nerves, etc.

When traction upon a viscus has to be exerted, as during Kraske's excision of the rectum.

When the solar or other reflex is obtained by traction upon peritoneal or other adhesions.

For forcible dilatation of a sphincter.

For section of certain structures, as the optic nerve in enucleation of the eyeball, or the spermatic cord in orchidectomy.

In very delicate operations, as extraction of cataract (unless solution of cocaine has been instilled previously).

In most cases for the preliminary incision through the skin.

And in cases where retching, vomiting, or other movement occurs in the lighter stages.

Less profound anæsthesia, or in some cases light narcosis only, may be employed during certain stages of many operations—*e.g.* :

The visceral peritoneum being normally insensitive, or nearly so, a lateral anastomosis or gastro-enterostomy is practically painless during the actual incision and suturing of the viscera and the anæsthesia may be relaxed.

During manipulation of the cerebral tissue in brain surgery.

During an operation upon a limb, if a tourniquet is tightly applied, the degree of anæsthesia required is less than when no pressure is used upon the nerves and vessels.

In cases in which the operation is completed within, say, a minute and a half or two minutes, without a continuance of the inhalation being necessary, the depth of the anæsthesia produced must depend upon the expected duration of the operation and upon the degree of pain. For example, for the removal of tonsils and adenoids the depth of anæsthesia must be greater than for adenoids alone. For such a painful procedure as the extraction of a tooth light narcosis must be avoided, for it is in such a case that one meets with an example of trouble resulting from administration of **too little** of the anæsthetic. This has been explained by the fact that when no anæsthetic is given, an impulse is conveyed reflexly, not only to the cardio-inhibitory, but also to the vasomotor centre which maintains the blood-pressure. When the painful operation is performed under **deep** anæsthesia, no reflex effect upon the heart or the vasomotor centre occurs, both being paralyzed; but under incomplete anæsthesia the vasomotor reflex is paralyzed, whilst the cardio-inhibitory is not. Blood-pressure falls immediately, and syncope occurs, which may prove fatal.

It must be remembered that there is a very great difference between **light** anæsthesia and **incomplete** anæsthesia.

From the foregoing brief statement the student will readily recognize the fact that to skilfully administer an anæsthetic various considerations must be taken into account to guide him as to the depth of anæsthesia.

The Choice of an Anæsthetic.—As already mentioned, better results are obtainable by a range of anæsthetics than by the exclusive use of one. In his choice the student will be guided by—

1. The age of the patient.
2. The condition of the patient.
3. The nature of the operation.
4. The known properties of the various anæsthetics.

1. **The Age of the Patient.**—The extremes of life influence the anæsthetist in his choice. In young children and old people ether is contra-indicated from its property of irritating the respiratory tract, and in the old suffering from arterio-sclerosis a blood vessel has given way under the profound stimulation of the circulatory system with ether.

Since "open ether" has been employed to such a large extent, this anæsthetic has been administered to much younger as well as to older patients than was formerly, when the "closed" method was invariably practised. Nitrous oxide is never given to the very young even for the shortest operations, and if administered to the elderly it is well to give it mixed with oxygen (generally spoken of as "gas and oxygen"). The latter element does away with the strain upon the heart occurring as a result of the deprivation of air. Chloroform alone is generally given to elderly patients, but, being a cardiac depressant, it sometimes is considered too risky for one whose coronary and other vessels may be calcareous. Under such conditions a little ether added to the chloroform (say 1 part of ether to 3 or 4 parts of chloroform) will be most beneficial even in the presence of a little bronchial trouble. Chloroform being such a powerful drug, if given to children it must be used with very great care. ACE or CE will be found an excellent anæsthetic for the young patients. ACE is a mixture of 1 part alcohol, 2 parts chloroform, and 3 parts ether. The risk of an overdose to an infant by giving ACE is small as compared with chloroform. CE is composed of 2 parts chloroform and 3 parts ether—*i.e.*, ACE minus the alcohol—but the proportions can be altered to suit individual cases. It is said that children bear anæsthetics very well, but the real reason of their apparent immunity is the innate caution exercised by the administrator, and also to a child's ready response to restorative measures should trouble occur. The fact that the inhibitory action of the vagus has not yet developed in infants and young children accounts for the absence of primary cardiac syncope in the very young. Between the extremes of life other circumstances must influence the choice.

2. **The Condition of the Patient.**—Certain conditions, the result of disease, accident, etc., prove an important factor in making a choice. Hewitt has pointed out how trouble may arise from **obstruction to respiration** due to adenoids and other growths, nasal obstruction, and spasm of the jaw, which frequently occurs in heavy smokers as a result of muscular hypertrophy following constant puffing of the pipe or cigar. Tumour or abscess of the neck, angina Ludovici, etc., by pressing upon the trachea, may embarrass the breathing; so also goitre, aneurism of the arch of the aorta, etc. Acute conditions cause greater embarrassment, as the more or less displaced or stenosed trachea has not had time to adapt itself to the trouble, as in the case of chronic and more slowly growing conditions. Ether alone is not very suitable, because in causing a turgid condition of the mucous membrane it tends to increase the obstruction. Chloroform, on the other hand, takes so much longer to anæsthetize the patient that spasm is not got rid of so quickly, and the trouble and danger are prolonged. A sequence will give a better result—viz., rapid anæsthesia, with ethyl chloride and ether, followed at once with chloroform or a mixture of chloroform and ether.

As a result of the work of Stiles, Guthrie, and others, a definite choice can be made in the anæsthetic for **septic abdominal cases.** In a series of such cases when chloroform was employed the large percentage of the patients developed acidosis or acetonæmia (chronic chloroform-poisoning), and died, whilst a small percentage recovered. When similar cases were anæsthetized with ether, the percentage was reversed, the majority recovering completely without any symptoms of acidosis. Although acidosis may occur under other conditions, an

anæsthetist is fully justified in avoiding chloroform in septic abdominal cases and in choosing ether, except under circumstances in which ether is contra-indicated. Mr. Rutherford Morison, however, still prefers chloroform during operations for septic peritonitis.

In **diabetics** ether is the preferable anæsthetic, whilst in patients suffering from **bronchitis** and other lung troubles ether must be avoided altogether, or mixed sparingly with chloroform.

Patients suffering from **renal affections,** who require an anæsthetic, are a source of great anxiety. In the present state of our knowledge it is almost impossible to say exactly what the choice should be. There are some who say chloroform should be given because ether tends to cause congestion of the kidneys, with suppression of their function. Others state that ether has "no specific effect" upon the kidney, whereas chloroform will sometimes cause albuminuria with apparently healthy organs, and increase renal degenerative changes in already diseased organs; it should consequently be avoided when renal trouble exists. I prefer ether, or a mixture of chloroform and ether, and the degree of narcosis should be as light as possible.

Cardiac Affections.—Valvular mischief is no contra-indication to the administration of an anæsthetic, provided compensation is good. Chloroform alone may be used with safety, but open ether or CE gives a greater sense of security. Every attempt *must* be made to avoid struggling on the part of the patient which calls upon the reserve force of the cardiac mechanism. It is in cases of disease of the cardiac muscle (fatty or other degeneration), as well as in affections of the cardiac nerves and ganglia, that the risk of an anæsthetic is so vastly increased. When called upon to give an anæsthetic to a patient with delirium cordis, or even intermittent or somewhat irregular pulse, the anæsthetist finds himself face to face with a knotty problem. In these, as well as in cases of failing compensation (fortunately very rare), chloroform should be avoided, and the heart stimulated by preliminary hypodermic injections of strychnine ($\frac{1}{10}$ grain, and repeated if necessary during the administration). Adrenalin (10 minims hypodermically) has been recommended, but when given subcutaneously it is so altered before it reaches the heart that it is almost useless. The anæsthetic chosen should be either ether alone or mixed with chloroform. In such cases as these the general rule, "Don't mind the pulse," must be laid aside. The heart being faulty requires constant attention, and if there is no one to attend to the condition of the radial pulse the anæsthetist must maintain vigilance over the affected organ by watching that in the temporal or facial artery. His attention must be concentrated upon his onerous task, struggling must be avoided as far as possible, and if cyanosis occurs the air-way must be kept very free, or oxygen be administered with the anæsthetic.

Jaundice.—The presence of this condition adds greatly to the risk of an anæsthetic. Whether chloroform or ether or a mixture be employed, great care is necessary, and either a weak percentage of chloroform vapour or open ether is the best choice to make.

Shock.—Shock or collapse, the result of an accident, hæmorrhage, intussusception, etc., indicates ether or a mixture containing it, and a preliminary injection (rectal, subcutaneous, or intravenous) of a pint or two of normal saline solution will greatly lessen the risk. In a case of intestinal obstruction, if fæcal vomiting is present, lavage of the stomach prior to the use of chloroform or ether is good practice.

3. The Nature of the Operation.—This will guide one at times in the choice of an anæsthetic. For a **short** operation—*e.g.*, incising a whitlow or cellulitis, avulsing a nail, removal of adenoids, extraction of two or three teeth, etc., where not more than a half or three-quarters of a minute will be necessary, nitrous oxide or nitrous oxide and oxygen will be, as a rule, found ample. If a somewhat longer period of unconsciousness is needed, ethyl chloride will be found more satisfactory, giving, as it does, frequently one and a half or two minutes. (*Very* rarely will it give four or five minutes, as is sometimes stated.) The administration of N_2O+O or of ethyl chloride can be prolonged so as to maintain anæsthesia for a longer period, therefore they may be used for operations elsewhere than upon the face. I have administered N_2O+O for thirty-five minutes and ethyl chloride for twenty-five minutes in exceptional cases. For operations extending beyond one or two minutes it is usual to give chloroform or ether, or a mixture. For operations likely to cause surgical **shock**—*e.g.*, excision of the breast, excision of the rectum, removal of large abdominal tumours, etc.—ether or CE should be chosen in preference to chloroform. **Cerebral** and **cerebellar** operations suggest to the anæsthetist chloroform, as causing less vascularity than ether, and frequently a preliminary dose of morphine will be appreciated by the surgeon, as it tends to diminish pulsation. This "mixed narcosis" must make the anæsthetist most watchful, as Hewitt has pointed out the increased risk of respiratory paralysis.

Morphine ($\frac{1}{4}$ grain) alone or with *atropine* ($\frac{1}{100}$ grain) hypodermically is frequently used by some surgeons and anæsthetists, because of the fact that the amount of anæsthetic required to maintain narcosis is less, sickness in many cases is diminished (although in some it is increased), and it prolongs sleep when the patient is put back to bed, diminishing the amount of groaning, crying, or shouting, which in a ward frightens and unnerves other patients whose operations are to follow. The risk of more ready respiratory paralysis must not be forgotten. I have heard a prominent surgeon state that the only benefit morphine seems to possess is that it diminishes the amount of anæsthetic required.

Scopolamine or *hyoscine* ($\frac{1}{100}$ grain) and *morphine* ($\frac{1}{4}$ grain) was originally intended to be administered hypodermically as an anæsthetic, but it is now used by some as an adjunct, like morphine and atropine, one dose being given the night before and another just preceding operation, which is performed under ether, chloroform, etc. The advantages of this method are similar to those just mentioned.

Chloretone in doses of 10 grains (or 1 drachm of elixir) three times a day for two or three days has given excellent results, both during and after the period of anæsthesia.

Anæsthetization of patients suffering from **exophthalmic goitre** is most satisfactorily conducted with open ether preceded by a hypodermic of morphine and atropine.

For **abdominal** operations, perhaps the only definite indication for ether is the presence of pus. Acidosis, which occurs after chloroform anæsthesia, is referred to on pp. 65 and 82. With the exception of purulent abdominal cases, the choice must be made upon other grounds. Some surgeons prefer chloroform because the respiratory movements are not so pronounced as when ether is used. Others prefer ether, as forestalling the shock which sometimes occurs as a result of peritoneal manipulations or of the diminution of abdominal pressure in the

removal of large tumours. What I have frequently found most advantageous is to anæsthetize with ethyl chloride and ether, and follow, if necessary, with CE, or, if abdominal respiration (which is more marked in men) interfere with the surgeon's manipulations, with chloroform alone.

When the operation demands that the patient be turned into the **semiprone** or **prone** position, it is well to choose ether or CE, as the ether stimulates the respiratory movements, and there is less embarrassment of breathing than with chloroform. An operation which causes the anæsthetist a good deal of anxiety is the removal of a piece of rib in a case of empyema. The patient is sometimes turned upon the *sound* side, and the already embarrassed breathing may thereby become more so. Some ether (CE or ACE) should be given to stimulate the breathing, and the patient should not be fully anæsthetized unless it is absolutely necessary. The amount of pressure of the patient's chest upon the table should be reduced to a minimum by supporting the shoulder of the affected side.

For operations about the **mouth, throat,** and **face,** chloroform, ether, or CE may be used according to the needs of the case. Anæsthesia

Fig. 3.—Crile's Apparatus.
(Down Bros., Ltd., London.)

having been induced, it can be maintained during the progress of the operation by pumping chloroform or CE through a tube by means of Junker's apparatus, or ether alone may be given by open method through Crile's apparatus (see Fig. 3). Professor Harcourt has introduced a modification of his inhaler, by which chloroform can be given on the plenum system in such cases as these. Some surgeons object to ether because of the greater amount of buccal secretion poured out upon the field of operation.

A more recent method of maintaining anæsthesia in these cases is by the intratracheal administration of ether. Briefly the procedure is this: After induction by one of the ordinary methods, a catheter is passed through the glottis down to the bifurcation of the trachea, and a warm mixture of ether vapour and air is pumped down the catheter. This method was originally used in **thoracic** surgery, the respiratory movements being diminished or suspended, but it is highly recommended in operations about the mouth and throat, because the inspiration of blood, septic matter, etc., during the operation is impossible, the current of air being always outwards through the partially occluded glottis.

In **dental** and other operations, during which the patient is sitting up, ether certainly should be used for inducing the anæsthesia, and ether alone, or mixed with chloroform if necessary, for maintaining it. Chloroform is contra-indicated, for Leonard Hill has demonstrated that it paralyzes the vascular mechanism, which antagonizes the hydrostatic effect of gravity, and syncope results through anæmia of the vital centres by gravitation of the blood to the most dependent parts.

If the actual or galvano-cautery or a naked **light** is to be employed, chloroform should be chosen, lest an explosive mixture of ether vapour and air become ignited, with disastrous effect. It must not be forgotten, however, that chloroform vapour is decomposed by a naked light, the resulting products having a most irritating effect on the respiratory tract.

To produce relaxation of the muscles for the reduction of a **dislocation,** chloroform or ethyl chloride may be more successful than ether.

In **obstetric** practice chloroform is almost universally employed.,

4. **Known Properties of the Various Anæsthetics.**—These have been incidentally referred to frequently.

Nitrous Oxide (N_2O) and **Ethyl Chloride** (C_2H_5Cl) give but a brief period of anæsthesia, and would not therefore be chosen for a more or less prolonged operation. The choice falls upon them for short operations of all kinds, although occasionally $N_2O + O$ or ethyl chloride may be employed for certain procedures of some minutes' duration.

Chloroform ($CHCl_3$) is a cardiac depressant, and lowers the blood-pressure ; consequently, for operations in which an amount of shock is feared or occurs, it should give place to ether, or should have some ether mixed with it. It is vastly less irritating to the respiratory tract than ether, and is preferable in bronchial troubles, and it should be chosen when arterio-sclerosis is present, being less liable to cause arterial rupture. Hewitt says it " has decidedly less effect than ether upon the renal functions." Concerning its use in renal disease, see p. 66. It is contra-indicated in purulent abdominal conditions.

Ether is a very decided stimulant of the heart and respiration, and therefore is chosen alone or in mixture when the patient's condition calls for this effect. It has in some cases a decidedly irritative action upon the respiratory tract, causing coughing, holding of the breath, increased and sometimes excessive secretion of mucus and saliva, which necessitates a reduction of the strength of its vapour, or even its replacement by chloroform. This effect upon different patients varies within very wide limits. When frothy mucus appears in the mouth, or when air is heard to be bubbling through the mucus in the bronchial tubes, the substitution of chloroform should be effected, as either condition is a fertile source of " ether pneumonia." This latter sequela sometimes follows even when there has been little, if any, secretion. Very rarely has bronchitis or pneumonia followed chloroform, except it be a septic condition after mouth cases. Ether should be chosen, whenever possible, when the patient is sitting up, for the reason mentioned under Dental Operations.

The question " Which is the safest anæsthetic ?" has not yet been definitely answered so far as chloroform and ether are concerned. $N_2O + O$ is the safest of all, the oxygen robbing the nitrous oxide of what little danger it possesses. " It has been stated that when nitrous oxide and oxygen are given together, acute dilatation of the heart

takes place, and fatal results follow if chloroform is given after this mixture" (Dudley Buxton). The risk with N_2O is one in very many thousands, perhaps millions. Ethyl chloride was thought to have little danger, but with more extended use it has been found to be not so innocent as believed. It has been calculated to have a risk of about 1 in 3,000. The interest attached to the comparative risk of chloroform and ether still holds. Although different authorities give different estimates, a rough average may be taken. The fatalities with chloroform number probably 1 in 3,000, and with ether 1 in 15,000 These figures are the actual deaths at the time of operation, and the upholders of chloroform say (and with justice) that the mortality does not, but should, include the deaths from after-effects, which with ether are undoubtedly greater than with chloroform. An after-effect of chloroform, which has only been studied within the last few years, is that of chronic chloroform-poisoning (see pp. 65 and 82), the patient dying two to five or six days after operation. The after-effects of ether are chiefly upon the respiratory tract, showing themselves as bronchitis and pneumonia (lobular or lobar). Until a vast amount of statistics are available, giving the mortality not only at the time of operation, but after, the question must remain unanswered, and the choice of an anæsthetic must be based upon general considerations, and not upon a single word in reply to "Which is the safest anæsthetic?"

Preparation of the Patient.—Prior to submitting a patient to operation (except in emergencies which do not admit of it) he should have a purge the night before, and, if necessary, an enema early in the morning. Some surgeons suggest a glycerin enema (especially in rectal cases) an hour or two before operation, so that the bowel may expel the remnants of that given earlier. In addition to the colon being empty, it is desirable that the stomach should be likewise; but it is a mistake to impose a *long* fast, else the patient may complain of a "sinking feeling" from sheer weakness. A light meal should be given about five hours before the time fixed for the operation, and in some cases a cup of tea only half an hour before it stimulates the flagging energy of a nervous patient. In emergency operations no preparation can be attempted, except, perhaps, in intestinal obstruction with fæcal regurgitation, in which lavage of the stomach helps markedly towards success.

It may be that in many cases local or constitutional treatment may be adopted by the surgeon—for example, in proposed operation upon a septic mouth or throat, antiseptic mouth-washes or some form of formaldehyde tablet would be ordered to be used thoroughly for some days; whilst for patients who bleed readily, treatment for a few days with calcium lactate or chloride might be adopted. Patients with acetone or diacetic acid in the urine should be given glucose, as suggested by Wallace and Gillespie.

The Administration.—The various anæsthetics are administered by various types of inhalers, and a very brief description of these must suffice for a chapter such as the present.

Nitrous Oxide.—The "gas apparatus" (Fig. 4) by which this is given contains, in iron bottles under pressure, the N_2O in liquid form. On releasing a pedal or a hand-tap, the N_2O vaporizes, and passes through a rubber tube into a bag having the capacity of a gallon or

more. From this bag it is allowed to pass at the will of the administrator into the face-piece, which has been accurately applied to the patient's face. An appliance for "continuous gas" administration has been devised, by which it is forced through the nose into the respiratory tract.

Nitrous Oxide and Oxygen.—The apparatus for this mixture (Fig. 5) is similar to the above, but in addition has an iron bottle containing liquefied oxygen, which is allowed to vaporize into a separate bag. Between the "twin bag" and the face-piece is the mixing-chamber, in which the "gas" and oxygen mix before passing through the face-piece into the patient's lungs.

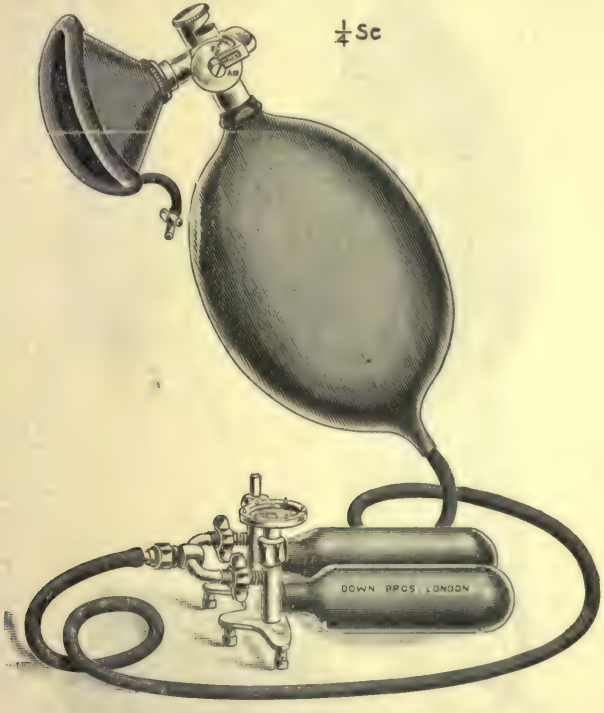


FIG. 4.—NITROUS OXIDE APPARATUS.
(Down Bros., Ltd., London.)

Ethyl Chloride.—Numerous forms of inhaler are made for this anæsthetic, but all agree in this—the anæsthetic is introduced into a "closed" inhaler, which, when applied accurately to the patient's face, allows him to inhale no more air than is contained in the inhaler along with the ethyl chloride, which rapidly volatilizes. One of the closed ether inhalers may be used without the necessity for a special apparatus.

Ethyl chloride may be given from a towel, folded cone-shaped, into which the anæsthetic is sprayed, and held *close* against the patient's face.

Ether is generally given from an inhaler, of which there are three forms —(1) a "regulating" inhaler, such as Clover's (Fig. 6), Hewitt's, or Probyn-Williams's; (2) a simpler form, such as Lucas's (Fig. 8) or Ormsby's; (3) an "open" inhaler, such as Allis's or a Roth-Drager,

or a metal frame covered with eight to a dozen layers of gauze. In the first form some ether is placed in the reservoir, and the air, passing between the patient's lungs and a rubber bag, circulates more or less through the ether chamber. The actual amount of air, which is breathed and rebreathed, allowed to pass through the ether chamber is regulated by a mechanical arrangement at the will of the adminis-

Fig. 5.—Gas and Oxygen Apparatus.
(Down Bros., Ltd., London.)

trator. The amount of ether vapour in the respired air depends not only upon the proportion which passes through the chamber, but also upon the amount of ether in it, as well as upon the temperature.

For giving ether with a preliminary administration of nitrous oxide a combination of "gas" apparatus and ether inhaler is employed, as shown in Fig. 7. By this means, or a preliminary inhalation of ethyl chloride, the patient is more quickly and pleasantly anæsthetized than when ether alone is given.

In Lucas's (Fig. 8) or Ormsby's more or less ether is poured upon a sponge or other absorbent in the inhaler, over or through which the

respired air circulates as it passes between the patient's lungs and the bag. A preliminary inhalation of ethyl chloride can be given before introduction of the ether.

Fresh air can only be admitted, when using either form of inhaler, by a partial or complete removal from the patient's face, and administration by either is called the " closed " method.

The " open " method is conducted by dropping or sprinkling ether into or upon an inhaler which has no bag, such as Allis's (Fig. 9), or a Schimmelbusch frame (Fig. 10) covered with several layers of gauze. If the inhaler has no pneumatic pad to fit the face, a roll of gauze or small towel should be used between the mask and the patient's face to prevent loss of the ether vapour. Splendid results may be obtained by " open ether."

Instead of a specially made form, removal of the bag from a closed inhaler gives an " open method," in which there is no rebreathing of

FIG. 6.—CLOVER'S INHALER.
(Down Bros., Ltd., London.)

the expired ether-laden air. Crile's apparatus for administering ether through the nose by the " open method " is figured on p. 68.

It must be borne in mind that a closed inhaler must never be used for administering chloroform or a mixture containing it.

Intravenous Anæsthesia.—A method of inducing and maintaining anæsthesia has more recently been used, and in suitable cases will be found valuable. It is the injection of a 5 *per cent.* solution of ether in normal saline directly into a vein. Great care must be exercised that no air be allowed to enter the circulation, and the fluid should be at body temperature (37° C.). Rigid asepsis is essential. Rood lately published an account of several administrations given by him, and he states that about 8 ounces of solution is sufficient to induce anæsthesia. The type of case in which this procedure is indicated is that in which some bronchial affection is present or is feared, and yet

chloroform is contra-indicated. It is especially indicated in cases of collapse from hæmorrhage requiring anæsthetization.

Still more recently a solution of hedonal has been employed intravenously, but the results do not justify its adoption on account of its serious after-effects. Further reference to it, therefore, will not be made here.

Like spinal anæsthesia, this method is a valuable addition to our armamentarium for use in suitable cases, but it cannot replace the older and well-tried methods.

Chloroform.—For the administration of this there are many devices, which may be divided into three classes. First, chloroform is

Fig. 7.—Gas and Ether Apparatus.
(Down Bros., Ltd., London.)

dropped or sprinkled upon a piece of absorbent material, which may be upon a metal frame, as shown in Fig. 10, or folded cone-shaped. This is placed over the face, so that the vapour as it falls is inhaled. As the vapour is more or less concentrated, great care is necessary that an overdose is not given. CE and ACE may be given by this method.

The second class is represented by Junker's inhaler (Fig. 11), in which air is *pumped through* the chloroform contained in a bottle, and the mixture of air and chloroform vapour passes through a rubber tube into the face-piece, which is lightly applied to the face. A maximum of 4 per cent. vapour is supposed to be given by this apparatus (as much as 15 per cent., however, has been estimated), but the strength varies with the amount of compression of the bellows,

the quantity of chloroform in the bottle, and the temperature. CE and ACE can be administered by this method also.

The third class is represented by the Vernon Harcourt inhaler (Fig. 12), in which air is *drawn over* the surface of chloroform contained in a bottle by the patient's inspiratory act. The percentage of chloroform vapour is regulated by the amount of air allowed to pass through the bottle containing the liquid. Inspiratory and expiratory valves regulate the direction of the currents of air. The face-piece

FIG. 8.—LUCAS'S ETHER INHALER.
(Down Bros., Ltd., London.)

must fit closely. The inhaler is so made that a maximum of 2 per cent. chloroform vapour is inhaled, and the percentage is regulated by a lever ; but the chloroform must be kept at a regular temperature of 15° C., and must not be shaken. The proportion of chloroform vapour may be increased to 2·5 per cent. by the introduction into the neck of the bottle containing the chloroform of a small funnel, which slightly narrows the airway.

FIG. 9.—ALLIS'S ETHER INHALER.

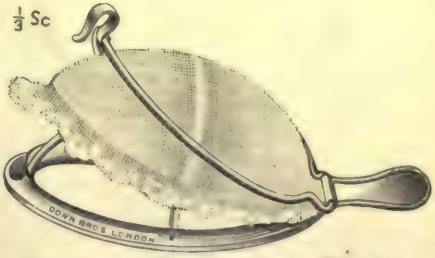


FIG. 10.—SCHIMMELBUSCH FRAME.
(Down Bros., Ltd., London.)

Having made a choice of the anæsthetic to be given and of the inhaler to be used, the patient is instructed what to do, and a few words of encouragement and assurance will generally aid in a successful induction of anæsthesia. The inhaler having been suitably "charged," the patient, having removed any false teeth, is made to inhale the anæsthetic. N_2O is generally given without any admixture of air, although sometimes a little is allowed by not completely closing the air-hole of the stopcock. If ethyl chloride is the anæsthetic, no

more air than that already in the inhaler should be allowed. If ether is being given without any preliminary N_2O or ethyl chloride,

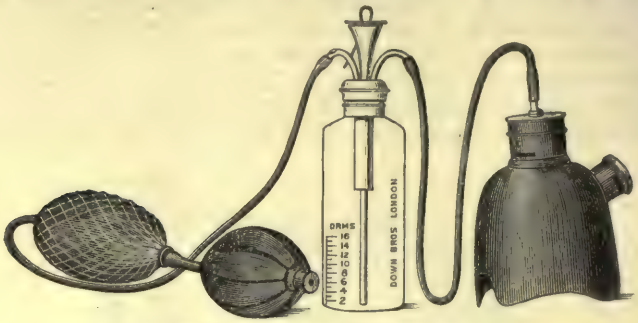


FIG. 11.—JUNKER'S INHALER.
(Down Bros., Ltd., London.)

it should be very gently added to the air being inhaled. Chloroform is also given in very small percentages at first, and gradually increased.

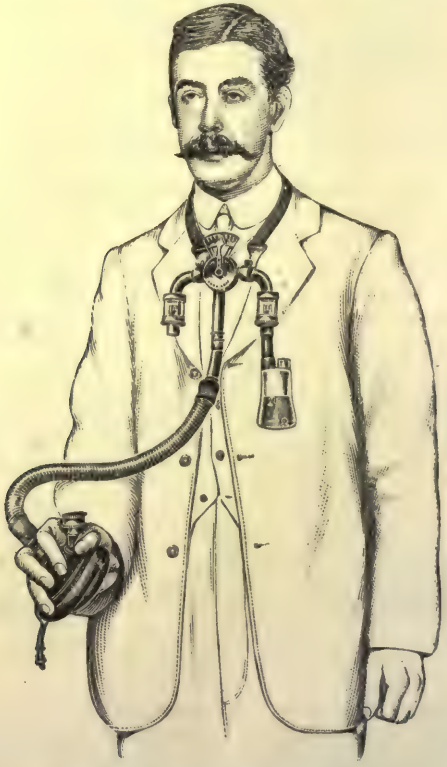


FIG. 12.—HARCOURT INHALER.
(John J. Griffin and Sons, Ltd., London.)

As the patient inhales more and more, he will be noticed to pass, with N_2O or ethyl chloride quickly, and with ether or chloroform more

slowly, through the stimulating stage. He may hold his breath, struggle, or attempt to remove the inhaler from his face if very nervous. He may speak of his symptoms, and tell how rapidly thoughts flit through his mind. His respirations increase in depth and frequency, and his pulse may be found fuller and stronger. He becomes more and more drowsy, and as unconsciousness sets in he may talk, sing, struggle, or commit some other involuntary act. Excitement and struggling occur as a rule with alcoholics, but they may be quite quiet. Voluntary **struggling** whilst the patient is still conscious must not be mistaken for the involuntary movements during early narcosis, as the procedure varies with the type. In the former, removal of the anæsthetic and some words of encouragement and instruction will usually be followed by a quiet passage into unconsciousness upon reapplication of the inhaler. For involuntary struggling a few breaths of air should be allowed, so that a more quiet condition may be resumed, and then induction of narcosis as rapidly as possible. As the patient inhales more and more of the anæsthetic, he more or less rapidly passes through the narcotic stage, in which the reflexes one by one disappear in no definite order. Muscular relaxation soon makes its appearance ; the arm, if raised, falls limply, and the tongue and muscles of the jaw and palate relax, shown by the onset of stertor. Relaxation of the abdominal muscles may be late, and especially in abdominal affections, in which they seem to have developed a "habit spasm" for the protection of inflamed viscera, it may be very late in the anæsthetic stage. Dudley Buxton considers that muscular rigidity denotes a need of more air or of the administration of oxygen. On watching the *eye reflexes*, they are found to go *generally* in the following order — the scleral, the pupillary, the corneal. Very occasionally it is found that the pupillary or light reflex persists after loss of the corneal. The eye reflexes go very early in young children, and are not of the same value as in adults. Various writers seem to use the terms "lid reflex," "eye reflex," "conjunctival reflex," and "corneal reflex," synonymously, but the student will readily find that he can often get no reflex closure of the lids upon touching the sclerotic (scleral reflex), whereas touching the cornea will be followed by a more or less brisk closure (corneal reflex). In other words, the corneal reflex is a much more delicate one than the scleral. If only these two terms were used distinctively as just indicated, it would simplify matters. The pupil reflex—*i.e.*, contraction of the pupil to light—is also a valuable sign. It is gradually lost, the contraction being in the early stages brisk, but becomes more and more sluggish until it is finally lost, and the pupil in deep narcosis, as also in the anæsthetic stage, is generally contracted and inactive. With continued administration of the anæsthetic the patient passes into the anæsthetic stage, in which no reflex act can be elicited by the anæsthetist. The pupil is contracted in the great majority of cases, all eye reflexes are abolished, and breathing is regular and quiet usually with chloroform, but more noisy with ether. Particular attention need not be paid to the pulse unless there is cardiac trouble, or unless surgical shock occurs.

Should the anæsthetic be given so as to carry the action beyond the third degree, the paralytic stage is entered, the pupil dilates, the patient turns livid, breathing gets shallower and slower from paralysis of the respiratory centre, and finally ceases, to be followed quickly by stoppage of the heart. (The radial pulse fails before the cardiac beats cease, as the heart is unable to empty itself under these circumstances.)

The administrator must watch carefully the signs whilst inducing anæsthesia, and he should endeavour to produce and maintain anæsthesia by judging the respiration and the condition of the pupil. He should keep, as far as possible, the corneal reflex as a "confirmatory test," and only use it at times, and not constantly, as is so often done. In ophthalmic surgery one frequently can get no assistance from eye symptoms through absence or disease of the second eye.

Anæsthetists should endeavour to retain one or more reflexes. In other words, they should try to keep the patient in as *light* anæsthesia as possible; but it must not on any account be *incomplete*. In testing for the corneal and scleral reflexes, two fingers, one to raise the lid and the other to touch the eye, should not be used. Much more satisfactory, as strongly recommended by Bellamy Gardiner, is the use of one finger thus: the pulp of the index finger gently raises the lid, then by slightly bending the terminal joint the finger-tip lightly touches the globe. By this means a reflex contraction of the orbicularis may be felt when it would otherwise be considered absent if the eye were held open with a finger.

Should a dilated pupil occur with absence of the corneal reflex, the administration should cease, unless the anæsthetist is "sure of his ground." It might be the first indication of the entry into the paralytic stage. Although a contracted pupil is usual during deep narcosis and in the third stage, dilatation *may* occur—after struggling, when the stomach contains food, with cyanosis, in surgical shock, with smart hæmorrhage, or in a very nervous patient. Dilatation is very common with ethyl chloride. After instillation of atropine, contraction occurs at no stage of the administration.

Pseudo-Anæsthesia.—This condition of false anæsthesia is more common in children than in adults. In the latter I always suspect it when the patient "goes over" very quickly, and it is particularly liable to occur when a delay takes place in beginning the operation after anæsthesia has been induced. The patient shows all the signs of complete anæsthesia—absence of corneal and other reflexes, contracted pupils, regular quiet breathing, etc.—but with the first incision or other painful process he wakes up, winces, and may groan, his pupils dilate, and the corneal reflex becomes immediately quite active. Should the anæsthetist suspect this false anæsthesia, he can apply firm pressure upon the supra-orbital nerve as it passes through its notch, or prick or pinch the patient's ear, when he may be successful in waking the patient up before the surgeon's knife does so. He will not always be successful. Needless to say, anæsthesia must be induced before the operator can proceed.

Difficulties and Dangers.—A brief consideration of the more important of these that the anæsthetist may meet with must now be undertaken. They may be immediate—*i.e.*, whilst the patient is on the table—or remote.

Hewitt maintains that **cardiac troubles** are secondary to **respiratory** embarrassment, which may or may not have been noticed, and the one thing needful is that the air-way be kept quite free, so that no undue obstruction to breathing can take place. Holding the breath, valvular lips (very common in edentulous patients), nasal obstruction, spasm of the glottis or jaw, the tongue falling back carrying with it the epiglottis, a foreign body in the larynx, and pressure of a goitre, an abscess,

or a tumour upon the trachea, are some of the causes of embarrassed breathing, and require such remedies as pushing forward the jaw by pressure upon the angles, or the introduction of a mouth-prop or gag, or, very rarely, the performance of tracheotomy. Keeping the face turned to one side allows the tongue to fall towards the dependent cheek instead of backwards.

If the **secretion of mucus** be profuse, the mouth and throat must be swabbed out frequently. The introduction of the corner of a towel into the dependent cheek often proves satisfactory by syphoning off the secretion. A change of anæsthetic may be necessary.

Struggling has been referred to already (see p. 77).

Retching and vomiting are frequently met with. If retching occurs in a patient who has been prepared, the proper procedure is to push the anæsthetic, in order to paralyze that reflex act. If, however, the patient has food in the stomach, and vomiting occurs, the anæsthetic should be withdrawn temporarily, so that the stomach can empty itself, and care should be taken to prevent any of the vomitus finding its way into the respiratory passage. This act of vomiting differs from the so-called vomiting which may occur in intestinal obstruction cases, where fæcal fluid is *regurgitated* rather than vomited, and during anæsthesia is particularly liable to be aspirated into the trachea. Preliminary lavage of the stomach in these cases diminishes the risk to a minimum, and it is advisable to turn the head well to the side and to keep the mouth open with a gag, so that, if further regurgitation takes place, the fluid will gain a more ready exit from the mouth.

Coughing generally passes off by temporary removal of the inhaler and subsequent administration of a weaker or less irritating vapour.

Sneezing is rare, and if a weaker vapour does not get rid of it, painting the nasal cavities with a weak solution of cocaine will usually act like a charm.

Rigidity may be local or general. It may affect the jaw only, or the muscles of the abdomen, of the thorax, or of a limb. Respiration is frequently interfered with, and if opening the mouth with a wedge or a gag, so as to establish a better air-way, does not relieve it, a change of anæsthetic may give a more satisfactory result; or Dudley Buxton's suggestion of administration of oxygen may cause complete relaxation. Extremely rarely is tracheotomy demanded as a remedial measure for rigidity. Rigidity of the recti abdominis sometimes gives the surgeon trouble during a laparotomy, and often the deepest possible anæsthesia will be required to produce relaxation. The muscles seem to have got into a condition of partial spasm from their habit of protecting diseased abdominal organs.

Cyanosis must be avoided if possible. The air-way must be kept free, and if keeping the mouth open does not suffice and ether is the anæsthetic employed, a beneficial effect may be obtained by removing the bag from the inhaler, so that there will be no rebreathing of expired air (open method). Alcoholics as a rule bear the deprivation of oxygen very badly, the result being that cyanosis is frequent with them; and as chloroform is particularly risky in these cases, a very general rule is "Give plenty of ether and plenty of air." Inhalations of oxygen may be demanded, but it is surprising how seldom its employment is necessary. Heavy cigarette smoking, by its effect upon the heart, seems in many cases to be a cause of cyanosis during anæsthesia. The Trendelenburg position predisposes to cyanosis at times,

and is only relieved by restoring the body to a more or less horizontal position.

Nervousness is very trying at times, and the anæsthetist may find great difficulty in reassuring and encouraging the patient. It adds greatly to the risk of the anæsthetic, and has been blamed for many fatalities. Several cases are on record where the patient has died of fright before a single inspiration of the anæsthetic vapour has been made.

Death *during* anæsthesia, unfortunately, does occur, but is not always *due to* the anæsthetic. **Fright,** as just mentioned, has caused death before an anæsthetic has been administered, and may account for some of the deaths which happen at the beginning of an administration. Being due to cardiac failure, these cases can probably never be resuscitated, although the treatment adopted be prompt and persevered in—lowering of the head, or even complete inversion of the patient; injection of strychnine ($\frac{1}{10}$ grain) or adrenalin (10 minims) into the heart substance (as circulation has ceased, hypodermic injection is useless or worse than useless, giving a false sense of security). Artificial respiration must be begun and maintained for some time (one to four hours). Massage of the heart from beneath the costal arch assists in the stimulation of the organ, and opening the abdomen so that the hand may be introduced to massage the heart through the diaphragm has been recommended. Rhythmical traction of the tongue during artificial respiration should also be employed.

Status Lymphaticus has been found post mortem in some cases of sudden death under anæsthetics. The spleen, thymus, and deep lymphatic glands, show a condition of hyperplasia, whilst hypoplasia of the heart and aorta also exist. There are no symptoms of the disease, and Peltauf says that persons suffering from this disease are particularly liable to cardiac paralysis. Treatment by artificial respiration, etc., seems to be of no avail.

Syncope may occur early in the administration, due to the chloroform vapour irritating the vagal terminations, with consequent cardiac inhibition; or it may occur during some operative procedure involving irritation of the vagus; or it may result when the optic nerve is cut in enucleation of the eyeball; and it has frequently occurred when *chloroform* is given to a patient sitting up—*e.g.*, in dental operations. Syncope is the result frequently of too little anæsthetic—*i.e.*, incomplete anæsthesia (as mentioned upon p. 64)—and to forestall it the anæsthetist should induce deep anæsthesia for the performance of painful stages of an operation. Treatment on the same lines as just described under Death from Fright must be used. As a prophylactic against cardiac inhibition, Embley has recommended as a routine a preliminary hypodermic of atropine, but this has not met with general acceptance.

Paralysis from **overdose,** fortunately, more readily responds to restorative measures than many other causes of death. When dilatation of the pupils occurs, with absence of corneal reflex and failure of respiration, the anæsthetic must be removed at once, and the most essential and often the only item in treatment required is artificial respiration, if begun very promptly. Tongue traction may be found of value in assisting to start breathing. As the heart fails after respiration, treatment need not be directed primarily to it, as in the before-mentioned conditions. If respiratory failure be noticed at once and before the heart fails, rarely does artificial respiration require

to be kept up for an hour or more. During a research into the pharmacological action of ethyl chloride which I conducted, some of my records showed that respiration ceased with the chest in the deep expiratory position. Forcible inflation of the lungs proved a successful means of treatment. For secondary heart failure, restorative measures on the lines above mentioned must be instituted.

A method of treatment which in rare cases might be possible is that introduced by Professor Crile of Cleveland, Ohio. He has demonstrated its success two or more minutes after the heart has ceased to beat. He maintains that the heart stops from failure of blood-pressure in the coronary arteries, and he has shown that injection of saline solution with 10 minims adrenalin (1 in 1,000) through an artery *into* the heart substance, together with artificial respiration, can reinduce both circulation and breathing. He found that in dogs recovery might take place as late as eight minutes after cessation of the heart, but degeneration of the brain cells followed such prolonged anæmia.

Obstruction of Respiration by a tooth, a piece of food or blood-clot, etc., entering the larynx, requires of necessity removal of the cause, if possible, by turning the patient over and slapping the back, and passage of a pair of forceps or gauze mounted on a holder to try to ensnare the foreign body. Occasionally the finger may effect its removal. Should none of these methods prove satisfactory, the only serviceable treatment is tracheotomy, followed by artificial respiration to restore automatic breathing, and subsequent removal of the object. Should the foreign body pass down into the trachea or bronchus, the immediate risk may not be so great, as some air may get into the lungs. Tracheotomy is useless except as a route for possible removal of the object. Simple spasm of the glottis may be remedied by tongue traction, and sometimes is relieved by a change of anæsthetic. Tracheotomy or laryngotomy may be required. A rare condition is **general respiratory spasm,** in which respiration cannot be induced even after tracheotomy. It is in such cases, Hewitt says, that venesection is indicated for relief of the overdistended right heart.

At this stage I must issue a note of warning regarding the fixing of the bellows and tube of Junker's inhaler. If they have been removed, and happen to be transposed, the *liquid* chloroform is forced into the face-piece, and death has actually resulted from entrance of the liquid into the respiratory tract.

Air Embolism from entrance of air into a vein at the seat of operation is very rare. If slight, recovery occurs naturally; but if much air enters, the case is hopeless.

Surgical Shock may result in death upon the table or later, and, being circulatory in origin, treatment must be directed accordingly (see p. 80). Hypodermics of strychnine have been declared to be useless, and as the blood-pressure is greatly lowered, the best treatment is injection of large quantities of normal saline solution into the loose tissues of the thoracic or abdominal walls or into a vein. This may be conducted during the performance of the operation. Also rectal injections of about ½ pint, and containing whisky, should be given at frequent intervals. Extract of pituitary gland in doses of 1 c.c. of 20 per cent. solution is stated to have a great and lasting effect upon the blood-pressure, and, consequently, is of service in cases of shock. In desperate cases injection of adrenalin into the heart muscle might prove beneficial. Adrenalin has been found by Pro-

fessor W. E. Dixon to be so altered in circulating through the body that *hypodermic* administration has little, if any, effect upon the heart.

Later or remote dangers include :

Cerebral Hæmorrhage, especially following ether given to a patient with arterio-sclerosis. Treatment is carried out on general lines.

Bronchitis or **Pneumonia** sometimes follows ether inhalation (*ether pneumonia*), and on rare occasions follows chloroform. Or it may be subsequent to the aspiration of vomited matter (*aspiration pneumonia*). Or it may supervene upon the entrance of septic matter in operations upon the mouth, etc. (*septic pneumonia*). Treatment is conducted here also upon general lines.

Acidosis, Acetonæmia, or **Acetonuria,** following chloroform, is commonly spoken of as **chronic chloroform-poisoning.** It seldom follows ether inhalation. It deserves here not only a word on treatment, but also on its symptoms. These latter vary in different cases, but some few of the following will be found : Vomiting (which generally sets in twelve to thirty-six hours after operation), restlessness, rapid pulse, delirium, convulsions, coma, air-hunger, cyanosis, Cheyne-Stokes breathing, slight jaundice, and a smell of acetone from the breath and urine. Smart and prompt treatment when symptoms show themselves (*late* vomiting should always arouse suspicion) may avert a fatal issue. A good purge should be given at once (castor oil is perhaps the best), and rectal or even intravenous injections of solution of bicarbonate of sodium, so as to restore the alkalinity of the blood. Lactate of soda has been recommended as more efficient than the bicarbonate. Strychnine hypodermically may be needful.

Wallace and Gillespie, who have investigated this condition very thoroughly, find that glucose, both as a prophylactic and a curative agent, is superior to alkalies. They give ½ to 1 drachm doses to children, and ½ ounce doses to adults, frequently repeated, either by mouth, rectum, or intravenously (but not subcutaneously). They have given as much as 10 ounces of glucose in twelve hours to a child of three years. When administered intravenously, a 2·45 per cent. isotonic solution is employed, which must be freshly prepared, and, of course, sterile.

Spinal Anæsthesia, or Analgesia.—A brief reference to this addition to practice must be made. It is still in its infancy, but it is being employed and studied by surgeons and anæsthetists of experience, and reports are being made from time to time. The procedure consists of injecting into the spinal canal an anæsthetic solution. Cocaine, being so toxic and unsterilizable, has given place to eucaine, novocaine, stovaine, and tropacocaine, stovaine, perhaps, being the most frequently used, tropacocaine probably coming second.

On the introduction of spinal anæsthesia, dorsi-lumbar injections were made for operations below the level of the umbilicus. More recently Jonnesco introduced neutral strychnine sulphate into the anæsthetizing solution to prevent, if possible, respiratory paralysis, and used this in " high " operations—*i.e.*, injection of 3 to 10 centigrammes stovaine with ½ to 1 milligramme strychnine sulphate between the first and second dorsal vertebræ, whereby anæsthesia of the head and neck was produced. This has been practised by McGavin, Canny Ryall, and others, but the risk of paralysis of the medullary centres is so intense that, for the present at least, its use is more or less suspended.

By means of dorsi-lumbar injections some surgeons claim excellent results, Barker's stovaine-glucose solution being perhaps the most frequently used, with or without the addition of small doses of strychnine. His solution is an isotonic solution of 5 per cent. each of stovaine and glucose, and he injects 1 c.c.

Whatever drug or solution be used, the *modus operandi* is the same. The skin over the lower dorsal and lumbar vertebræ is sterilized, and, with the patient bent well forward, a boiled hollow needle is passed between the last dorsal and first lumbar or between the first and second lumbar into the spinal canal. A few drops of the cerebro-spinal fluid are allowed to escape, and 1 c.c. of a 5 or 6 per cent. solution of the drug chosen is injected through the needle into the canal, and the patient laid flat. In the course of about five minutes anæsthesia of the limbs and lower part of the abdomen results in most cases, and amputations, etc., may be painlessly performed. Failure to produce anæsthesia results in some cases, and collapse or other untoward symptoms in others; but in either case non-success is doubtless one's inability to graduate the dose. With the general anæsthetics (and also with other drugs) an amount found satisfactory for one patient may be quite inadequate for a second, and may be too powerful for a third. I have no doubt but that this holds good in spinal anæsthesia. When once the drug is in the spinal canal it cannot be removed, and if unpleasant or even disastrous symptoms develop, one is helpless to do more than treat symptoms. In cases in which anæsthesia does not occur, either another dose must be injected or resort be made to chloroform or ether inhalation.

Not only have immediate ill-effects—*e.g.*, headache, nausea, vomiting, etc.—occurred in some cases, but remote ones, such as paralysis of various muscles (even those of the eye), paraplegia, spinal meningitis, etc., have given cause for much anxiety. Death has not been rare.

Needless to say, the patient is quite conscious during the operation, and his being able to hear all that may be said or discussed concerning his condition is considered by many as a great disadvantage to this procedure; and, in addition, he may find the maintenance of certain positions not only irksome, but unbearable.

This method of producing anæsthesia or analgesia is not likely to be generally adopted at present, but doubtless it will be useful in some cases where a general anæsthetic is out of court. It may be taken, therefore, as an *addition* to the list of anæsthetics, but cannot replace older and well-tried procedures.

Local Anæsthetics.—These are employed to diminish or abolish sensibility at the site of operation.

There are three distinct methods of producing anæsthesia locally:

1. **Instillation and Painting.**
2. **Infiltration.**
3. **Freezing.**

The first method is employed to render a mucous surface insensitive, but the second or third is necessary when the skin must be anæsthetized.

1. **Instillation and Painting.**—A 2 to 5 per cent. solution of cocaine *instilled* into the eye will cause insensibility, so that many operations may be painlessly performed—*e.g.*, iridectomy, cataract extraction, tenotomy, and even enucleation of the eyeball.

With a 2 to 10 per cent. solution *painted* locally tonsils may be removed, and turbinectomy performed with little, if any, pain. It will also diminish discomfort in passing a probang or dilator down the œsophagus. Similarly, it may be used upon the genito-urinary tract—*e.g.*, in cauterization of urethral caruncle, etc.

Cocaine is so toxic that it is well to use weak solutions—viz., 2 to 5 per cent.—and even these are sufficient to cause distressing symptoms in some patients. *Symptoms of poisoning* include pallor (with a cold, moist skin), giddiness, tremors, headache, palpitation, rapid and feeble pulse, vomiting, and shallow breathing, followed, it may be, by prostration and drowsiness.

Eucaine, novocaine, stovaine, and tropacocaine, are preferred by some surgeons as substitutes for cocaine, being less toxic, and because solutions can be sterilized by boiling. Solution of cocaine decomposes on boiling.

2. **Infiltration.**—Solution of cocaine, alone or mixed with other drugs, injected into the *gum* is frequently used for teeth extraction. It is not without great risks. In addition to syncopal attacks, such grave sequelæ as sloughing of the gum and necrosis of portion of the maxilla have been known to occur, and a case is on record of a young woman who had to be sent to an asylum for some weeks after extraction of a number of teeth, for which operation cocaine had been injected. Injection into the gum is contra-indicated when it is swollen, and also when pyorrhœa is present. Eucaine, etc., are used in making local anæsthetic solutions, which are sold under various fancy names.

Cocaine, eucaine, etc., may be injected *into the dermis* (**Schleich's method**) to produce local anæsthesia of the skin, and the addition of adrenalin to the solution is usual. This latter causes a local anæmia, with diminution of the blood-stream, and the effect is a double one—the amount of cocaine required is less, and the duration of the anæsthesia is prolonged.

Barker's solution is as follows :

Eucaine hydrochloride β	0·2
Sodium chloride	0·8
Adrenalin chloride	0·001
Water	100·0

Mix.

The needle of the syringe is passed into the dermis, and a series of drops of the above solution is injected, forming a wheal, along the site of the intended incision. If done properly, only the first needle-prick is felt by the patient. Various operations are performed under this method of producing local anæsthesia. A ligature or tourniquet placed, when possible, on the proximal side of the field of operation benefits largely this method of anæsthesia.

What is considered much more satisfactory than any of the foregoing is a solution of quinine and urea hydrochloride. It is non-toxic, and possesess the advantage of maintaining anæsthesia for some days, so that after-pain is in many cases entirely absent. It is also hæmostatic. A 1 per cent. solution is recommended for infiltration, but for instillation or painting as much as 20 per cent. solution may be required. Several minutes are necessary for the advent of anæsthesia after infiltration of this solution.

3. **Freezing.**—Ethyl chloride has almost entirely displaced ether spray and the application of ice and salt. When a fine jet of ethyl chloride is played upon the site of operation it quickly volatilizes, and,

absorbing heat from the skin, the latter rapidly freezes, becoming white, brawny, and insensitive. An incision can now be made without pain, but as the circulation becomes restored the patient may suffer agony, especially if the part is very sensitive—*e.g.*, when a nail has been removed under this method. Ethyl chloride spray is occasionally used for teeth extraction, but freezing should never be employed unless the pulp of the tooth or root is dead, otherwise great pain results.

CHAPTER VI

INFLAMMATION AND ITS RESULTS

Phenomena of inflammation: its causes, symptoms, and treatment—Sepsis—Terminations of inflammation, resolution, organization and repair, suppuration, ulceration, gangrene.

THE following is Burdon Sanderson's definition of inflammation: **"Inflammation is the succession of changes which occur in a living tissue when it is injured, providing the injury is not of such a nature as to at once destroy its structure and vitality."**

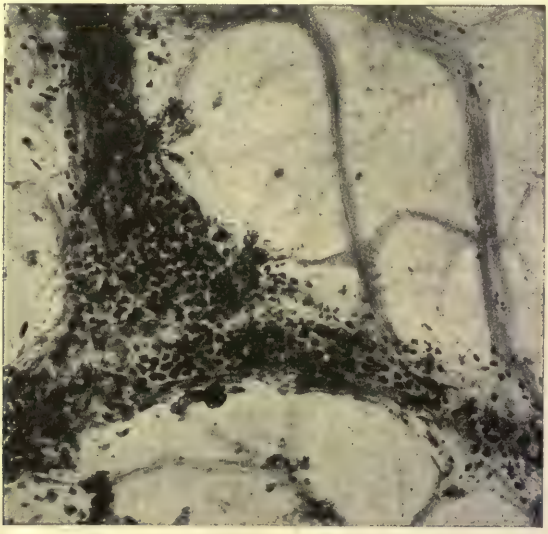


FIG. 13.—ACUTE INFLAMMATION IN THE OMENTUM OF A GUINEA-PIG.
(Beattie and Dickson.)

The phenomena of inflammation is Nature's effort to ward off a danger, whether it arises from trauma or as a result of bacterial infection. If the resistant power of the tissues be normal, and the strength of the invading or destructive force not too great, the defence will be sufficient to bring about resolution, otherwise certain changes in the parts affected occur. The former favourable result is less likely when there is bacterial infection, since the organisms tend to multiply in the tissues and produce toxins which keep up the irritation.

Phenomena of Inflammation.

1. **Vascular Changes**—(A) **Hyperæmia.**—There is a dilatation of the vessels of the affected area, caused by "the action of the irritant directly upon the vascular walls, or through the intervention of their local vasomotor apparatus; . . . dilatation of the vessels occurs even when all connection with the cerebro-spinal vasomotor centre has been severed" (Beattie and Dickson).

The dilatation is associated with temporary **acceleration** of the blood-stream. This is followed by **retardation,** which increases till **stasis** is brought about, which may be followed by **thrombosis.** Meantime the white cells have collected along the walls, and the red cells have formed into rouleaux.

(B) **Exudation.**—As soon as the white cells collect along the walls of the vessels, the **polymorphonuclear variety** pass between the endothelial cells of the wall into the tissues beyond by means of vital amœboid action. The migration ceases when, or if, thrombosis takes place.

The function of these migrated cells is to act as protectors of the body by attacking the foreign body or micro-organism causing the inflammation, which they do by absorbing it into their substance, and carrying it off, or digesting it. It used to be thought that this action of **phagocytosis,** as it is called, was due to a power inherent in the leucocytes, but it is now known that the white cells deprived of the serum have no such power, and require the property in the serum which renders the bacterium, etc., fit for absorption; this substance, or property, has been called **opsonin.**

Positive chemiotaxis is the attraction of the phagocytes by the bacteria.

It happens that under certain conditions the leucocytes do not attack the invading force, or do so very feebly, when a condition known as **negative chemiotaxis** is set up. A generally enfeebled constitution, bacteria of exceptional virulence, and certain specific substances, as alcohol, chloroform, quinine, and strong solutions of sodium and potassium, have the power of producing this condition. For further particulars, see Chapter III.

We thus see that the body is protected by the leucocytes, which may, however, be overcome by the virulence of the attacking force, or by the influence of certain chemical substances.

All the white cells which pass from the vessels do not act as phagocytes; some are broken down, setting free **fibrin ferment;** some are absorbed by the large cells, which are produced by the tissue changes.

Meantime the red cells are also passing through the walls of the vessels, not by vital activity, but by mechanical pressure, and produce, when broken up, a discoloration of the tissues.

The normal exudation of the liquid part of the blood is increased in inflammation to such an extent that the lymphatics are unable to carry it off; **coagulation** takes place on the fluid meeting with the fibrin ferment liberated by the broken-down leucocytes.

The exudation of inflammation differs from that of health in three particulars: (*a*) It contains more albumin; (*b*) it contains fibrin ferment; (*c*) it is excessive in amount.

2. **Tissue Changes**—(*a*) **Connective Tissue.**—Cloudy swelling of the cells, with proliferation, occurs. The connective-tissue fibres swell,

and if the inflammation be chronic there is an increase of the white fibres.

(*b*) **Organic.**—Cloudy swelling of cells, which is often followed by fatty degeneration.

(*c*) **Necrosis.**—Death of the part is a tissue change, but is perhaps better looked upon as a result of inflammation.

(*d*) **Pigmentation.**—This is due to the hæmoglobin of the broken-down red cells being deposited in and around the cells of the permanent tissue.

Causes of Inflammation.

Predisposing.—Bad circulation arising from diseased arteries or veins. Impaired nerve-supply, rendering the part more liable to the effects of irritation or trauma. Certain conditions of the blood arising from the presence of poisons, ingested, or not excreted. Certain constitutional diseases, as syphilis and tubercle.

Exciting.—The two great causes of inflammation are trauma and infection by micro-organisms.

Trauma.—Under this heading we may include direct violence and chronic irritation, as well as the effects of heat and cold, electricity, and chemical agents.

Infection by Micro-Organisms.—These may attack from without through an abrasion of the skin, or from within through the blood or lymph channels, or by passage through the tissues.

The two may be combined ; thus trauma may produce a wound which becomes infected with micro-organisms, and is then said to be septic.

Sepsis and Infection.

A wound or other breach of the skin surface is said to be septic when repair is interfered with, owing to fouling of the surface, which has led to implantation of micro-organisms, or it may be due to direct infection. In old days a septic condition of operation wounds was a common occurrence owing to the failure to recognize its microbic origin. Later, **antiseptics** were used to destroy the organisms, and to prevent them attacking the site of operation. The modern surgeon relies on sterilizing everything which has to be used at the operation, and rendering the skin surface and his own hands scrupulously clean ; this is the **aseptic** method.

The organisms usually responsible for the septic condition are the pyogenic bacteria, staphylococci and streptococci ; but it may be due to certain microbes which are non-pyogenic, as the *B. proteus vulgaris* and *B. proteus hauseri*. These latter organisms can **only develop in fluids, or dead tissue,** and in pus, serum, or blood-clot ; they cause putrefaction, multiply quickly, and produce poisonous substances, giving rise to local and general symptoms. Pyogenic organisms can invade and multiply in the ordinary tissue of the body, and give rise to spreading inflammation.

It should be remembered that **sepsis** is at first a local condition, and gives rise to secondary or constitutional symptoms from the absorption of toxin manufactured by the organisms at the site of the septic condition ; the organisms themselves are not found in the blood, and do not spread through the body. The process is therefore essentially different to **infection,** in which the organisms are in the blood, and may spread to any part of the body, being either a **general infective process**

from the beginning, in which case the organisms develop and multiply in the blood-stream, or a **local infective process,** in which case the disease is at first local, and spreads by means of emboli through the lymph channels.

The organisms causing infection are of a different type to those giving rise to sepsis, the former being capable of development in living tissue; and they are usually taken into the body, not through an open sore, but through some very slight abrasion, or even through the sound skin; they also enter through the mucous membrane of some part of the respiratory, digestive, or genito-urinary system.

The results of the two forms of poisoning, especially in the more serious cases, are often not very apparent clinically, but arise from a totally different source.

In the case of sepsis, when there is extensive poisoning, the condition known as **sapræmia,** or septic intoxication, is brought about, and arises from the chemical poison manufactured by the organisms at the point of attack being absorbed and circulating in the blood. In the case of infection, the condition known as **septicæmia** is produced by the development of some pathogenic organism in the blood, which is infective, so that some taken even at a distance from the original focus will reproduce the disease if injected into an animal, while in the case of sapræmia the blood is non-infective, and does not contain micro-organisms.

In sepsis, when the dose of poison absorbed is small but long continued, **hectic fever** is produced. This is associated with an evening rise of temperature of several degrees, and with prolonged and intractable suppuration.

When the absorption of toxins is greater, but not large enough to produce sapræmia, the condition is known as **traumatic fever.**

The **symptoms** of poisoning by sepsis or by infective agents may be very slight, or may be extremely serious, and will vary according to the amount of poison absorbed or the virulence of the infecting organism.

Those of sapræmia and septicæmia are not unlike, and consist of an initial rigor, followed by a high temperature, which usually remains up unless in the worst cases, when it falls to subnormal, and is accompanied by a rapid, weak pulse. In *pyæmia* the temperature is intermittent, falling sometimes to normal between the rigors, the tongue is dry, and the appetite lost. There is early constipation and late diarrhœa, accompanied by great exhaustion. In bad cases of septicæmia there are petechiæ beneath the skin, and dyspnœa is often seen before a fatal issue.

Pyæmia.—This is a variety of infection which is characterized by a severe rigor, followed by an intermittent temperature, and accompanied by the formation of multiple abscesses. The micro-organism usually responsible is the *Streptococcus pyogenes,* while occasionally the *Staphylococcus pyogenes aureus* is found. The condition is brought about by the detachment of an infective embolus, which travels perhaps to a distant part of the circulation till it becomes blocked, and there sets up inflammation leading to a similar condition to that found at the original focus. It most commonly occurs in acute inflammation of bone and during the puerperium.

Treatment, as might be expected, is much more hopeful in sapræmia than in septicæmia, since in the former we are dealing with a chemical substance supplied as a rule from one focus, while in the latter there

is a vital organism in the blood. As, however, septicæmia may arise from an initial sepsis, the obvious line in all cases is to destroy the original focus of infection by cleansing, and removal of all putrefied and diseased tissue, and in infective cases, in addition, by numerous incisions or by amputation ; in pyæmia this must be carried out well above the local focus. Stimulants and abundant fluid nourishment should be given. Normal saline solution, 1 drachm to the ounce, injected intravenously at frequent intervals, has given good results.

In septicæmia and pyæmia the injection of antistreptococcic serum is often useful. These conditions must at all times be regarded as most serious, and treatment, to hold out any chance of success, must be prompt and energetic to the point of being heroic.

It must be remembered that, while septicæmia is a special state of grave infective poisoning, probably produced by different bacteria, and occurring usually in the subjects of alcoholic or other deterioration, yet all micro-organisms capable of developing in living tissues produce infective disorders or diseases both medical and surgical, which, however, seldom proceed to such a degree as to merit the name "septicæmia."

Types of Inflammation.

Catarrhal.—This is an inflammation of the mucous membrane, which becomes swollen owing to the exudation passing into its substance. It is preceded by a dry, painful condition, during which there is little or no formation of mucus, and succeeded by an abundant secretion of mucus mixed with leucocytes, which results in a mucopurulent discharge ; such a condition is present in an ordinary "cold."

Croupous.—This is characterized by coagulation of the exuded plasma, which produces a membrane coated with fibrin. It is met with frequently in serous membranes, as the pleura, peritoneum, and synovial membrane, and gives rise to the formation of adhesions.

Interstitial (parenchymatous) inflammation of an organ occurs when the process involves either its functional substance or the fibrous tissue.

Signs and Symptoms of Inflammation.

The classical signs of inflammation are—

Heat.—Caused by the increased flow of blood through the part.

Redness.—Caused first by the increased flow, later by the slower flow, and later still by deposit of the colouring matter of the red cells, which, however, gives a slightly yellow tint to the part.

Swelling.—From exudation ; it will vary with the distensibility of the part.

Tenderness.—Pain produced by pressure, and corresponding to the area which is the site of inflammation, is frequently present before the patient complains of pain.

Pain.—From the force causing the inflammation in trauma, and from irritation of the nerve-endings by arterial pressure and tension of the exudate. The pain is greatest where the fascial covering is dense and the parts cannot expand. There is often **referred** pain from the seat of the inflammatory process to some other part supplied by branches of the same nerve as that which supplies the inflamed area.

Pain may be described in various ways. When the skin is affected, as **burning ;** when bone or organs having a capsule, as **boring ;** when suppuration is pending, as **throbbing,** etc.

Impairment of Function.—Owing to mechanical injury; pain; and protoplasmic poisoning by toxins or micro-organisms.

The constitutional symptoms are—

Fever.—Caused by increased heat-producing activity of the tissues, probably owing to stimulation of the heat-producing centre by the poisons developed by, or responsible for, the inflammatory process. The fibrin ferment liberated on the disintegration of the leucocytes has also this power.

Associated with fever there is increased frequency of the pulse and of respiration. An interference with the physiological processes of salivation, digestion, and excretion, producing a diminution in secretion of saliva, gastric juice, pancreatic juice, bile, and sweat, and in the excretion of urine and fæces.

In chronic inflammation there is not continued rise of temperature, but usually an intermittent one.

Treatment of Inflammation.

The fundamental principle in treating all acute inflammatory conditions is **rest** for the part, both physical and physiological; without it no other treatment will be of much avail. The exciting cause, or the one prolonging the process, should be removed so far as practicable; thus, foreign bodies, whether extraneous matter or dead tissue, as bone, acting as a foreign body, should be removed, and pus should be evacuated whenever present. In such ways it may be possible to remove all the local foci and cure the condition. In other cases, when the inflammation is more diffuse, it may not be possible to remove the whole trouble locally. The local hyperæmia should be relieved by posture, or blood-letting by means of leeches, cupping, etc.

In diffuse inflammations incisions are made to relieve tension, and to bring an increased amount of blood-serum to the part to help in fighting the invading force. Cold is useful in the early stages, but should not be prolonged. Heat, in the form of a large amount of Gamgee tissue or cotton-wool fastened in position by a firm bandage, is useful in some forms of inflammation, and moist heat, as poultice, for unbroken skin, and boracic fomentations for broken or unbroken skin, is useful, especially when pus is forming.

Constitutional Treatment.—When the patient is in a low state, a stimulating plan of treatment should be adopted, together with the administration of such drugs as quinine and carbonate of ammonia, and mild purgatives; while, if the condition is one of high blood-pressure, smart purgatives and low diet should be adopted, and such drugs as aconite, antimony, and acetate of ammonia, administered.

For infective inflammations serums and vaccines are often useful.

When the inflammation becomes **chronic,** or is of that type from the beginning, in addition to the above methods of treatment some form of counter-irritation should be adopted, either mechanical, as by friction, the cautery, etc., or by means of such drugs as iodine, cantharides, Scott's dressing (ung. hydrarg. co., containing over 10 per cent. of camphor, covered with soap plaster). Pressure and massage are also useful in chronic inflammation. The constitutional treatment should be largely the administration of drugs suitable to the disease responsible for the local inflammation.

Bier's Hyperæmic Treatment.—In both acute and chronic inflammation this treatment is useful in many cases.

Its advantages, according to Willy Mayer, are :

1. Suppression of the infection.
2. Avoidance of suppuration in many cases.
3. The possibility of using small instead of large incisions in cases in which suppuration has already set in.
4. Hastening the course of the pathological process.
5. Favouring absorption.
6. Diminution of pain.
7. Its wide field of usefulness.

The treatment of Bier consists essentially in the production of a venous or arterial hyperæmia, and is carried out by means of elastic bandages, cupping-glasses, or hot-air boxes. The former two produce a venous, the latter an arterial, hyperæmia.

Bandages are usually employed for inflammatory processes occurring in the head, extremities, or scrotum. Where the position renders these inapplicable, cupping-glasses are used; while hot-air boxes, made of wood or metal for producing arterial hyperæmia, can be made to suit the special part to be treated.

In using the bandages it must be remembered that the object is not to completely obstruct the venous return, but only to partially do so, and not to interfere with the influx of arterial blood, so that there may be an increase of the quantity normally present in the part. In this lies the rationale of the treatment, which acts by increasing the inflammatory symptoms to abort the inflammation, or, to quote Willy Mayer again—

" To increase this beneficent inflammatory hyperæmia resulting from the fight of the living body against invasion, is the aim of Bier's hyperæmic treatment."

Thus restating the theory long since announced that inflammation is not in itself a diseased condition, but is rather Nature's method of resisting disease, and only when that resistance is overcome is disease established.

The pulse should always be felt below the bandage, and its application should not cause the patient any pain; while no hyperæmia should be **visible** in the part under treatment, nor should the part distal to the bandage become white, indicating the accumulation of lymph only. This is usually brought about by applying the bandages too loosely.

There should be no dressings on the diseased part during the application of the bandage, which should be placed on proximal healthy tissue, never over the affected area.

For acute inflammation the treatment should be kept up for about twenty out of twenty-four hours. For chronic affections two or three hours per day are sufficient.

The use of **suction-glasses** to produce hyperæmia and for their mechanical effect has been largely increased by the research of Klapp, and they are now usually referred to as Klapp's glasses, though originated by Bier.

By their use hyperæmia is created in the underlying tissues as well as in the skin.

The glasses can now be had in many shapes. To them a rubber bulb is attached, either directly or with the intervention of a tube or a suction-pump. The tubes on the larger glasses are fitted with a stop-cock for the purpose of obtaining an air-tight closure of the cup when

the proper amount of hyperæmia is produced. Before applying a cup the edge should be coated with vaseline.

Pus, when present, as in an abscess, must be liberated by an incision, which need not be large, and the cup then applied; this induces a very complete and painless evacuation. The same precaution used in applying the bandages is applicable to the glasses. The time of their use should be about three-quarters of an hour per day, divided into five minutes of application and three minutes' interval.

The **hot-air** arterial hyperæmia is particularly advantageous for **chronic inflammation** and **neuralgia,** and may be produced in a hot-air chamber or by the hot-air douche. The chambers are of various sizes, and have one or more apertures for the limb, protected by flaps of felt, and another for the pipe of the lamp through which the air enters. There are apertures in the lid of the chamber for escape of moisture and for insertion of the thermometer. The heat should never be so great as to cause any pain or inconvenience to the patient, but great heat can be borne, as high as 250° F. often being registered without incon-

Fig. 14.—Klapp's Suction Glasses (Bier).

venience. Care must be taken, however, that a burn is not inflicted, owing to the somewhat insensitive nature of the skin under high degrees of temperature.

For using the hot-air **douche,** the pipe of the lamp, to which is fitted a tube with a ball-point, may be utilized.

The duration of the application of hot air should be about half an hour each day.

Chronic Inflammation is really the effect of certain specific infections, especially tuberculosis, and will be described under their respective headings.

TERMINATIONS OF INFLAMMATION.

Resolution.

This is the most favourable result possible, the tissues being restored to their former condition. It only occurs when the injury has not destroyed the vital action of the tissues affected. Should

thrombosis take place, complete restoration cannot be effected. After resolution has taken place, the circulation which had accommodated itself to resist the injury or bacterial invasion is restored to its normal condition, the leucocytes, which are not disintegrated or carried off by the lymphatics, gradually rejoin the blood-stream, while the vessels which have become dilated recover their tone, and the fluid exudation is removed by the lymphatics of the part.

Organization.

When thrombosis has occurred, but there is no suppuration, **fibroid thickening** takes place as a healing process. The exudate and the surrounding connective tissue undergo certain changes which are technically called **repair.** This will be described here, and the description holds good for the process of repair under whatever conditions or in whatever tissue it occurs, whether in the healing of wounds of the connective tissue, muscle, or tendon, or the uniting of a broken bone; for fibro-cicatricial tissue or its equivalent is present in the process, except in those rare cases where resolution or regeneration takes place without its intervention, owing to the close and accurate apposition of the parts. The amount of cicatricial tissue will differ according to the severity and condition of the wound.

Granulation tissue tends to reproduce the original tissue; the simpler the structure, the more perfect the reproduction. Thus epithelium, fibrous tissue, tendon, and bone are reproduced, while muscle and nerve tissue are not, but are replaced by scar tissue. Composite structures are repaired by cicatricial tissue, or reproduction of original cells, according to the character of their elements.

Process of Repair.—(1) Exudation of leucocytes which cleanse the wound by the removal of useless tissue and blood-clot.

(2) Fibroblasts appear, derived from the multiplication of the connective-tissue corpuscles, and perhaps from endothelial cells of the neighbouring capillaries. These form a lining layer of tissue, which lies on and between the surfaces of the wound. The leucocytes disappear by returning to the circulation, or by serving as nutriment for the fibroblasts.

(3) Vascularization of this lining layer takes place by an outgrowth from neighbouring capillaries of small processes of protoplasm, which unite with similar processes from the other side; a canal is then formed in them, through which blood is transmitted from the vessels from which the processes have sprung. Thus, a vascular tissue—known as **granulation tissue**—is formed, the essential features of which are a number of branching and joining capillaries, with large nucleated cells and some intercellular substance between them.

(4) This granulation tissue is changed into **fibro-cicatricial tissue** by the fibrillation of the intercellular exudate, the fibres contract, compressing the cells and the newly-formed capillaries between them; **scar tissue** is thus formed, which by continued contraction becomes smaller and less vascular, till in the case of small wounds the resulting mark is scarcely discernible. At the same time there is being formed a new covering derived from a growing inwards of the healthy epithelium from the sides of the wound.

Granulation tissue differs from plastic exudation in that it contains bloodvessels, and possesses a homogeneous intercellular substance instead of coagulated fibrin, which has now disappeared.

Scar tissue differs from healthy areolar tissue in that no lymphatics and no yellow elastic fibres are present.

Healing used to be divided artificially into healing by various **intentions.** The student need not trouble himself about these, as healing under present-day conditions of surgery is either by **granulation,** when there has been loss of substance and the surfaces are not in apposition, or where septic changes have occurred; or by **primary union,** where there has been no loss of substance, sepsis, or injury to neighbouring tissue, and the parts have been kept in close apposition. In this process there is merely a thin layer of blood-clot between the cut surfaces, which speedily becomes converted into a microscopic layer of granulation tissue, the amount of cicatricial tissue is very small, and there is little or no subsequent scar. All healing is by means of granulation tissue, but healing by granulations means that, owing to loss of substance or wide gaping in a wound, the space has to be

FIG. 15.—HEALING OF WOUNDS: INCISED WOUND FOUR DAYS AFTER INJURY. (Beattie and Dickson.)

filled by granulation tissue, instead of its acting merely as a cementing substance; the resulting scar is, of course, larger after the healing of such a wound.

Such terminations of inflammation are the desirable ones resulting when there is little or no invasion by micro-organisms. When this occurs the condition of things is not so satisfactory, and repair and healing are postponed by the intervention of one of the following unfavourable terminations of inflammation:

Suppuration.

By the action of the pyogenic (pus-producing) micro-organisms the tissue around the inflamed area is broken down into a more or less fluid state, and repair is prevented by the exudate also becoming

degenerated. The resulting semi-liquid material derived from these sources is called **pus,** while the term **suppuration** is applied to the process of its production, and the cavity in which it is contained is an **abscess,** which may be **acute** or **chronic.**

Acute Abscess.—This formation is only possible where there has been extra corporeal assistance, though it is claimed by some that in certain debilitated subjects the condition may be produced by auto-infection. There must be present micro-organisms; those usually responsible for the ordinary acute abscess are *Staphylococcus pyogenes, aureus, albus* or *citreus.* The members of this group of organisms do not show much tendency to diffuse themselves in the surrounding tissues, but may penetrate the small bloodvessels, and spread by the circulation. *Streptococcus pyogenes* is the group responsible for grave spreading suppuration of tissue such as cellulitis, and also for many pyæmic and septicæmic conditions. Many other organisms have been found in abscesses, as *Micrococcus cereus, Staphylococcus pyogenes tenuis, Bacillus coli communis,* and *B. pyocyaneus,* which latter is associated with the production of green and blue pus; it has been found on the surface of the body, and is met with in otitis media and in the green pus of the pericardial and pleural cavities.

In certain diseases, as pneumonia, glanders, gonorrhœa, and typhoid, the specific organism causing the condition sometimes gives rise to abscess formation. In connection with the **typhoid abscess,** an interesting point to remember is that the organism may lie dormant for many years before giving rise to pus formation. Kirk has reported (*British Medical Journal,* November 20, 1909) a case occurring six and a half years after the attack of typhoid fever, in which there was an abscess cavity in the lower half of the medullary cavity of the femur, the pus from which contained the typhoid bacillus and no other micro-organism.

Signs and Symptoms of Acute Abscess.—There is an area of inflammation indicated by the classical symptoms. The part of this area where there is a swelling is, while the abscess cavity is being formed, hard and tense; but when pus has formed it becomes soft and fluctuating, while the pain becomes somewhat less intense, but more throbbing in character. The abscess, if unopened, makes its way to the surface, and the pus finds an outlet by the bursting of the thinned skin. It sometimes happens, however, that the pus finds a path of less resistance in some other direction than to the skin surface; thus we frequently have pus appearing at a considerable distance from the original site of the abscess cavity, or perhaps making its way into some hollow organ.

When the abscess is of considerable size, symptoms of pressure on neighbouring structures manifest themselves.

Abscess formation causes considerable constitutional disturbance, which will vary according to the size of the abscess and the importance of its position. A **rigor** is sometimes experienced, and there is considerable elevation of temperature. Meantime the protective influences have been at work, and the number of leucocytes have increased, so that they may try to cope with the work to be done. If a blood-count be taken, it is found that the normal 7,500 to each cubic millimetre is greatly increased, and this is often a useful guide as to the existence of suppuration.

When an abscess is deep seated, the local signs are usually absent or

to be detected with difficulty, and the diagnosis has often to be made from the history and the constitutional symptoms.

Treatment of Acute Abscess.—As soon as pus has formed there is only one treatment, and that is to evacuate it ; this is usually done by making an incision at the most dependent part, and deepening it till pus is found. Where important strictures are involved it is well to lay aside the knife when the skin has been cut, and use a director or pair of dressing-forceps to find the pus ; when this has been evacuated the cavity should be drained, or packed with iodoform gauze.

Chronic Abscess.—This differs from an acute abscess in that there is little local sign of inflammation, nor is there much constitutional disturbance ; the pus gathers very slowly as a rule, and is really broken-down tuberculous matter, since it may be broadly stated that most chronic abscesses are tuberculous in character. They usually form in connection with bone or lymphatic glands. There is a great

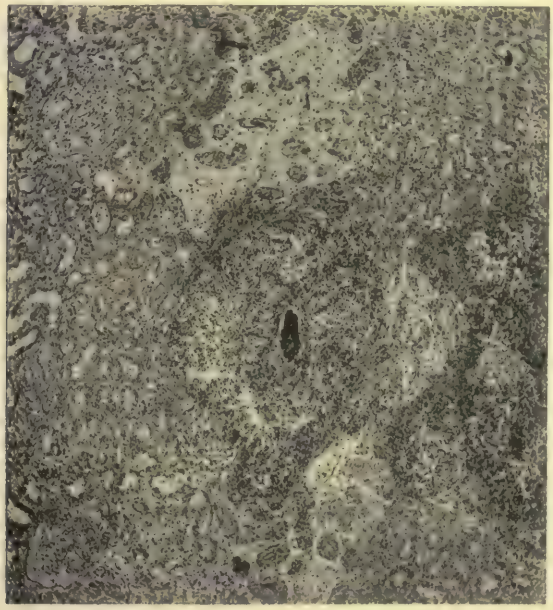


Fig. 16. Abscess in Kidney.
(Beattie and Dickson.)

tendency in these abscesses to burrow for long distances, and come to the surface at a point far distant, sometimes following the lines of the bloodvessels. As an instance of this the **psoas abscess** may be cited which usually begins in the dorsal or lumbar regions of the spine, and ends by pointing at Poupart's ligament. Such an abscess may, however, travel directly backwards and to the side of the spine, and end as a **lumbar abscess.**

Occasionally chronic abscesses undergo spontaneous cure, and seem to dry up, probably owing to the healing of the original site of infection. It is more usual to find prolonged suppuration leading to profound constitutional disease of the internal organs, especially of the liver, spleen, and kidneys, which undergo a process of degeneration termed **amyloid change,** or **lardaceous disease.** The constitutional disturbance is evidenced by the presence of **hectic fever.**

Treatment of Chronic Abscess.—Probably the best method is to open the abscess and clear out the contents, together with the lining pyogenic membrane, and close the external wound. In treating these abscesses it should be remembered that they are not as a rule septic, and that the risk of admitting sepsis, especially in a case where there is a long burrowing tract, is very great.

Sinus and Fistula.—These often occur in connection with an abscess.

A **sinus** is a communication between the original site of suppuration and the external or mucous surface.

A **fistula** is an abnormal canal between two hollow organs, or between a cavity and the external skin.

Both these conditions are usually due to incomplete healing after an abscess cavity has been opened.

They should be laid freely open, scraped, packed with iodoform gauze, and allowed to granulate from the bottom.

Various conditions not associated with an acute abscess are also called "fistulæ"; such are congenital and traumatic fistulæ. There are also some associated with disease or secondary to an abscess—*i.e.*, biliary, fæcal, perineal, and anal fistulæ.

Ulceration.

Ulceration may be described as a superficial abscess, the suppuration being on the surface. It is a progressive destruction of the tissues in which the solid parts melt away into a liquid discharge without the separation of visible portions of dead tissue, as the result of inflammation of the surface, particularly in an individual, or at a part of low resisting power where repair is not efficient and progressive.

All forms of ulceration have one feature in common—*i.e.*, the original tissues are first infiltrated by cells foreign to the part which destroy them and occupy their place, then in their turn these cells perish, and are thrown off with a fluid discharge, and thus a progressive destruction of tissue takes place.

That ulceration, which is a termination of inflammation, and is caused by the pyogenic micro-organisms, will alone be considered here. The ulcers due to specific infection—*i.e.*, to one definite micro-organism—as the syphilitic and tuberculous ulcers, and those due to malignant disease, are part of the disease, and fall naturally under its heading for description.

The student should remember in this connection that the specific ulcers are really a symptom of the disease in the course of which they occur, that they are usually due, with the exception of hard and soft chancres, to the attack of an organism working within the body, and so are of a different pathological order to the infective ulcers, the result of inflammation; but the local manifestation of progressive superficial-tissue destruction is somewhat similar, and therefore they fall, rather unfortunately, under the classification of ulcers, when in reality they are ulcerative processes of a definite disease.

Variety of Ulcers.—According to their condition ulcers are artificially divided into healthy, weak, indolent, inflamed, sloughing, and eczematous. Obviously, one ulcer may undergo all these changes. The following table shows the condition present under the various names, and in addition that of an irritable ulcer, which deserves separate mention, in that it appears to be of a distinct class and to have a

different history, and that of a varicose ulcer, which is the direct result of the condition of the veins:

Ulcer.	Surrounding Skin.	Edges.	Surface.	Base.	Discharge.	Pain.
Healthy	Soft and free from congestion	Graduated with healing line	Smooth and even, covered with fine red points of healthy granulation	Free	Very slight serous	Painless
Weak	Unhealthy	Irregular, no healing line	Raised above surrounding skin, covered with flabby granulations (proud flesh)	Œdematous	Slight and pustular	Little pain
Indolent or callus	Congested	Irregular	Smooth, and covered with yellow layer, or feeble granulation	Hard, and fixed to subjacent tissues	Thin	Little pain
Inflamed	Hot, red, and painful	Sharply-cut	Dark red	Red and angry	Serous or pustular and bloody	Painful.
Sloughing (active, spreading, if untreated)	Œdematous and infiltrated	Sharply-cut	Covered with dirty yellow material; no granulations present	Thickened and fixed	Offensive, not often purulent	Not marked
Eczematous	Eczematous	May partake of any character in other points				
Irritable	Purple	Raised and irregular	Only slightly below skin, purple, slight slough	Slight induration	Scanty	Marked especially at certain points
Varicose	Congested, and marked by presence of enlarged veins and pigmentation	Vary	Glazed	Not fixed	Scant serous	Aching

The irritable ulcer has rather uncommon characteristics. It is commonly met with in women of a neurotic temperament. Its usual site is the external malleolus. It is very painful, the pain being of a shooting character, and at various points over the surface of the ulcer the pain is found to be intense, probably due to exposed nerve filaments.

In examining all ulcers the following six points should be observed:

Condition of surrounding skin.
The edges of the ulcer.
The surface.
The base.
The nature of the discharge.
The presence of pain or tenderness.

Treatment of Ulcers.—The lines on which to treat ulcers are clear and simple enough, but the results when an extensive surface of skin is broken down are not encouraging.

There should be rest for the part. The surface of the ulcer should be rendered aseptic, and kept so as far as possible.

With a view to carrying out these conditions, the skin around the ulcerated surface should be gently washed with castile soap and a soft nail-brush. After this the whole surface, including the ulcer, is covered with a warm boracic fomentation, renewed two or three times if necessary. In the case of an old chronic ulcer covered with a tenacious slough, the surface should be gently scraped with a Volkmann's spoon before the application of the fomentation.

When the ulcer is clean, the best treatment is to cover the surface with a small piece of perforated oilsilk cut the size of its surface, and applied after steeping in boric lotion. On top of this some sterile lint and Gamgee tissue should be placed, and firm, even pressure exerted on bandaging. This dressing is renewed every second day. If this treatment be accompanied by rest to the part, and the general condition of the patient attended to, the ulcer, in many cases, will assume the characteristics of a healthy ulcer, and healing progress to a satisfactory issue, new epidermis gradually spreading out and covering in the broken surface.

If the surface be very large, **skin-grafting** will have to be resorted to. The method of Thiersch is that almost universally adopted now. It consists in removing, by means of a special broad strong-bladed knife, thin strips of cuticle down to the papillary layer. These are usually taken from the inner side of the patient's thigh, the skin of which is held tight by special toothed retractors. The grafts are then laid with the under-surface uppermost upon a warm sponge, and are transferred from this to the surface to be covered. Care should be taken that the edges of the graft overlap the raw surface, as there is considerable shrinkage. The surface is then covered with perforated protective tissue, and an aseptic dressing. Dry gauze, or gauze smeared with sterilized vaseline, may be used when there is no reason to anticipate any discharge. The same form of dressing is applied to the limb from whence the graft has been removed. If dry dressing has been used, it may be left in position for a week or ten days; by that time the grafts will have united. Other forms of dressing should be changed every second day. Before grafting, the surface of the ulcer should be scraped free of granulations.

When a small surface only is to be covered, the original plan of Reverdin may be adopted. This consists of pinching up a small piece of skin and removing it with a pair of curved scissors. A portion of the cutis vera is here taken as well as the cuticle.

Should the granulations become excessive and weak in vitality, rising above the surrounding tissues, it will be necessary to touch them with bluestone or solid nitrate of silver. If the ulcer does not become healthy by the above treatment, stimulation must be carried out by means of application of lotio rubra, which consists of zinc. sulp., grs. ii.; tinct. lavand. co. and spirits rosmarini, āā ℥xx.; acid. boric., grs. x.; aq. dist. ad ℥i.

To relieve the intense pain sometimes met with in the irritable ulcer, it has been suggested that the painful points should be undercut, with a view to dividing the nerve filaments.

Arterial hyperæmia produced by Bier's hot-air treatment has proved of benefit, especially in old ulcers of the leg.

Total excision of the ulcer and covering the raw surface with skin grafts is a successful method of treatment, especially in old-standing and irritable ulcers.

When the ulcer is due to some specific cause or disease, treatment must, of course, be directed to the constitutional or local causation, as well as to the ulcer itself.

Gangrene.

The final termination which may result from inflammation will now be considered, and though gangrene may be due to many causes other than trauma and the attack of pyogenic micro-organisms, the whole subject will be considered together to avoid confusion.

By the term "gangrene" is meant the loss of vitality in a considerable mass of tissue, which thus becomes a foreign body. This may occur in soft or hard tissue. In the former the process is called "sloughing," and the product a "slough"; in the latter "necrosis" and "sequestrum" are the respective terms applied.

Causation of Gangrene—1. Predisposing.—Anything which lowers the vitality of the tissues, as old age, poor circulation, traumatism, and loss of innervation; also certain diseases, as Bright's and diabetes, owing, no doubt, to the changed condition of the blood.

2. **Direct.**—(1) *Causes acting principally by arrest of circulation*—

(*a*) Arrest of arterial supply.
(*b*) Obstruction of the circulation in the affected part
(*c*) Obstruction to venous return.
(*d*) Diminished *vis a tergo* (force.)

(2) *Causes acting on the tissues*—

(*a*) Traumatic: Mechanical violence, heat, cold, etc.
(*b*) Causes giving rise to acute inflammation (infective gangrene).

3. **Indirect** (spontaneous gangrene).—Gangrene is, under this heading, due to arrest of circulation from disease of the bloodvessels or changes in the blood.

Varieties: Senile, diabetic, and those due to thrombosis, embolism, or endarteritis.

Gangrene may be **dry** or **moist.** The former condition is produced when there is obstruction to the blood entering a part, but none to its leaving it, and is met with in cases of atheroma of terminal arteries. The part becomes dry, hard, and of a dark brown colour from the broken-up hæmoglobin. The moist variety is produced when there is obstruction to the blood leaving a part, but none to its entry, so that the tissues become engorged. It is usually met with in obstruction to the venous return, mechanical or from disease, though it is also produced by acute arterial thrombosis in traumatic gangrene by pressure on, or rupture of, the main artery. The parts become discoloured, purple, black, or green, and are more or less moist.

Either form may take on septic changes when the process becomes very much more rapid, and the dead tissue very offensive. If septic changes do not occur, and the area of necrosis is not large, the condition may undergo spontaneous cure by absorption of the dead material, or if the area be large a portion may become absorbed, and

the rest cast off. When, however, sepsis has been admitted, an inflammatory action takes place before the part can be cast off, and this process may be so severe that life is endangered.

The **line of demarcation** is the limit of the gangrene, and forms when the process reaches a part the vitality of which is too great to be destroyed. It is evidenced by the sharp contrast in colour between the normal and dead tissue.

The **line of separation** is a different thing, being in reality a line of active ulceration which forms along the extreme end of the *living* tissue. It is usually oblique.

There is no hæmorrhage when the separation of a gangrenous mass takes place, owing to the thrombosis of the vessels.

The **Symptoms** of gangrene generally are those associated with a debilitated constitutional condition or a special disease, together with the local condition producing pain and septic poisoning.

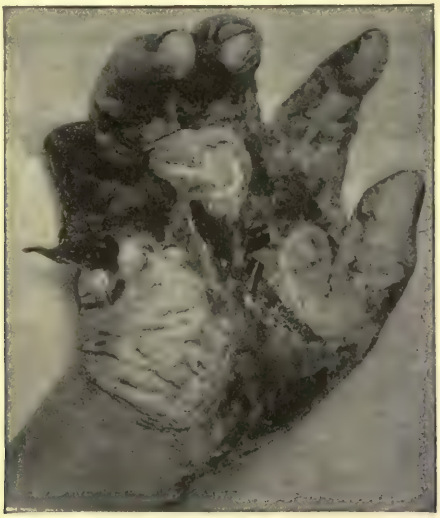


FIG. 17.—MOIST GANGRENE.
(Stewart's "Surgery.")

Treatment.—This is local, which will differ according to the conditions present; and constitutional—the relief of pain and the support of the system, together with the treatment of any special disease which may be present. Opium is a useful drug to relieve pain, and may be given in 1-grain doses every four hours. Constipation, however, should be avoided as far as possible.

Cascarilla, gentian, and ammonia are useful as tonics. If a febrile type of fever be present, a mild tonic course should be adopted; if an asthenic type, strong stimulation is necessary.

The question **when amputation should be carried out** has to be answered in many cases of gangrene, and the following broad lines may be laid down:

Before the Line of Demarcation Appears.—In (1) local gangrene following severe injury to tissue, except in frost-bite; (2) gangrene following a wound or ligature of the main artery; (3) gangrene consequent on severe infective processes.

After Demarcation.—Generally in spontaneous gangrene, if the patient be strong enough to bear the strain ; otherwise, as in many cases of senile gangrene, operate early.

Bier's hot-air treatment has proved useful in cases of embolic, senile, and diabetic gangrene. Care must be taken, in view of the insensitive condition of the part, that severe burns are not produced without the knowledge of the patient.

Special Forms of Gangrene.

Embolic.—Embolus is a primary cause of gangrene. It lodges where a main trunk bifurcates. The most common causes are—

(*a*) Fibrin, which has been deposited upon a diseased patch of a large vessel or in a fusiform aneurism.

(*b*) A vegetation from the left side of the heart.

Embolic gangrene is usually of the dry variety.

When the main artery of a limb is blocked, gangrene should not supervene any more than when it is ligatured, provided that there exists no local or constitutional cause of weakness which would render permanent and progressive the naturally lowered vitality of the part pending the establishment of collateral circulation.

Symptoms.—Pain at the point of the block and down the course of the vessel. There is no pulse on the distal side, sensation is partly or wholly lost, the temperature is lowered, and a sense of weight is imparted. Whether dry or moist gangrene result depends on the state of the arteries. When healthy, stagnation occurs in the veins, and moist gangrene takes place ; but if there be atheroma of the arteries, it will have induced a previous anæmic condition, and dry gangrene occurs. The line of demarcation will occur above or below a joint, owing to the blood-supply being better in that situation.

Treatment.—The very strictest antiseptic treatment of the entire limb should be carried out. It should then be wrapped round with moist sterilized gauze, and covered thickly with tissue, the whole being firmly bandaged. The limb should be elevated to promote venous circulation. If in spite of treatment gangrene supervene, asepsis should be maintained, and separation may be awaited, unless in the case of moist gangrene in young persons, when the process may be assisted by separating healthy from dead tissue and sawing the bone. When sepsis has occurred, the amputation had better be carried out through healthy tissue, and if the process is spreading and acute, the line of separation should not be waited for, amputation being carried out well above the diseased tissue.

Senile Gangrene. — This condition attacks certain parts in old people which are distant from the heart, as the toes, fingers, and tips of the ears. In these cases there is almost invariably calcareous degeneration of the arteries, a weak heart, and a poor condition of the blood. Under these circumstances any slight trauma may produce thrombosis, or it may result from the gradual deposition of fibrin upon the diseased walls of the vessels.

Symptoms.—The gangrene, which is of the dry type, may begin as inflammation when a slight trauma has been experienced, and gradually spread from a central slough. Where there has been no injury, the toes gradually shrivel up and become black. The process begins frequently on the inner side of the great toe. Considerable pain is

present, and the constitutional symptoms are marked. Exhaustion often supervenes from want of sleep and continued pain, and failure of heart, lungs, or kidney may lead to a fatal termination.

Treatment.—If the patient be likely to bear the strain of separation of the parts, the limb should be made aseptic and kept as warm as possible by means of dressings. Many cases do well under such treatment, but in many, perhaps most, it is wiser not to expose an old and enfeebled person to the trial of endurance, but rather to operate well away from the disease, where the tissues are normal and the pulse of the main artery can be felt.

It is usually found that, even when the mischief is limited to the foot, amputation should be performed above the knee in order to obtain good results.

Gangrene from Thrombosis.—Thrombosis is not usually a primary cause of gangrene. It generally results from endarteritis obliterans, or is secondary to a constitutional blood-poison in which the blood is rendered more liable to coagulation and the vessels themselves affected. The femoral artery is often the one diseased, and the condition is usually one of dry gangrene.

Treatment.—Constitutional. Amputation after line of demarcation has formed.

Diabetic Gangrene.—This form of gangrene is no doubt largely due to the arterial degeneration common in diabetes. Trauma is usually the exciting cause. The condition may be of the moist or dry variety.

Treatment.—Constitutional for the disease. Amputation, unless the vessels are unusually healthy, had better be after the line of demarcation has formed.

Raynaud's Disease.—This condition differs from other forms of gangrene in that there is no organic disorder of the bloodvessels or tissues present to set up the gangrene, and, indeed, death of the parts frequently does not occur. The condition is probably dependent upon a nerve lesion, central or peripheral, which produces vasomotor spasm, both locally and sometimes in the kidneys, giving rise to hæmoglobinuria.

The disorder is most frequent in the neurasthenic type of female, and may be associated with nervous prostration or a sudden fright.

The spasm of the arteries produces local anæmia, while that of the veins produces congestion ; and if the process proceeds to its ultimate issue, gangrene of the dry type is produced. The extremities are the parts affected, those of the upper limb suffering more frequently than those of the lower. The onset may be sudden, or may be prolonged to a considerable period.

Symptoms.—There is a good deal of pain. Peripheral neuritis, which is often present, gives rise to painful areas interspersed with others where anæsthesia exists. There is no fever, and, as already stated, hæmoglobinuria may be present.

Treatment.—Efforts should be made to prevent gangrene from taking place. Constitutionally, tonics and stimulating food should be given, while locally the circulation should be improved by friction and by keeping the part protected from cold or trauma, which might readily lead to death of the part. Electricity in the form of the

electric bath is useful, and, as already pointed out, hyperæmic treatment.

When or if gangrene does occur, the parts should be left to be separated or absorbed, only taking care that sepsis is not admitted.

Ergot Gangrene.—Frequently seen in the East, but seldom in this country. It is due to the presence of ergot in rye used for making bread.

Traumatic Gangrene.—This may directly affect the tissues or the bloodvessels.

In the former case the injury is from crushes or blows of a severe nature, as in machinery accidents or from prolonged pressure, as in bedsores or splints carelessly applied. The resulting gangrene is, as a rule, of the moist type.

Treatment.—Amputation, if the patient can stand the shock, holds out the best chance of life where the parts are pulped beyond hope of recovery; otherwise, the affected area should be rendered aseptic and the general strength kept up.

Traumatic Gangrene from Injury to the Bloodvessels is associated with ligature of a main artery, when the condition of the arteries themselves is bad, and has produced a lowered vitality of the limb, with thrombosis, or with obstruction to both arterial and venous circulation from any cause.

Treatment.—Here, again, if the trauma is such as to injure the tissues beyond hope, amputation had better be promptly carried out; while, if there is any reasonable hope of saving the limb, the injured vessels should be tied, and the parts treated according to the local requirements, the whole limb being rendered and kept aseptic. Where the gangrene is the result of ligature, and is of the dry variety, a line of separation can usually be waited for.

Bedsores.—These should be prevented when possible by careful nursing. There should be no contamination of the points of pressure, and the bedclothes should be kept tight and smooth. The skin should be examined frequently, and if any signs of reddening occur, the back sponged with spirits and white of egg, and afterwards dusted with a mixture of boric and zinc powders in equal proportions. The particular part likely to be affected should be supported on an air or water cushion. If the skin breaks, the resulting sore may be treated with resinol ointment.

Infective Gangrene.—Here the cause of the gangrenous condition is the presence of micro-organisms which by their action cause the death of the part.

Acute Infective Spreading or Emphysematous Gangrene.—This is a serious condition, which often ends fatally.

It usually attacks those of low resisting power, whose opsonic index is lowered by hereditary weakness or by a course of fast living.

It usually has as its originating cause some severe form of trauma associated with the ingraining of the wound with dirt, though occasionally in those specially predisposed the condition follows injury of a trifling nature.

The infection is usually a mixed one, consisting of the organisms of

sepsis, together with some special one, as the *B. aerogenes capsulatus* which produces characteristic œdema of the parts. The *B. œdematis maligni* is present instead of the former in those cases where the disease is more superficial, and is sometimes described as a separate condition—malignant œdema. It is, however, difficult, if not impossible, to distinguish the condition clinically from other types of acute gangrene.

Symptoms.—The wound is unhealthy, and has a thin serous discharge, often tinged with blood. As the inflammation spreads, the limb becomes swollen and often very painful, while there is some brawniness of the tissues. Discoloration followed by gangrene takes place, and as the gas which is characteristic of the disease develops there is distinct crepitation. Meantime the general condition shows signs of acute poisoning, there is a high temperature and delirium, or the temperature may be subnormal.

Treatment.—Early and high amputation is the only treatment which holds out any great hope of life, and care should be taken that the operation wound is not contaminated by any discharge from the affected area.

To prevent the supervention of infective gangrene, care should be taken to carefully cleanse any wound which is contaminated by such material as earth or refuse matter. Peroxide of hydrogen may, with advantage, be used as a cleansing agent, and iodoform gauze as drainage material for the wound, which should not be closed by stitches.

Cancrum Oris.—This is a severe form of stomatitis, which assumes a gangrenous condition rapidly. It is usually found amongst the children of the very poor in large centres of population, and is thought to be due to specific bacteria and spirochætes, which are found at the margin of the gangrenous patch.

The condition is generally found on the inner side of the cheek, and rapidly spreads if untreated, involving the bones of the jaw.

Symptoms.—The child is rapidly prostrated, and symptoms of general poisoning quickly supervene, since the digestive, respiratory, and lymphatic systems are quickly involved.

The patient has a grey appearance, and lies with open mouth, from which issues a flow of foul-smelling, blood-stained saliva.

Treatment.—Instant and thorough. The necrosed tissue should be cut away, and the clean bleeding surface underneath swabbed with pure carbolic acid. Subsequently the mouth should be cleansed at frequent intervals with Condy's fluid or Sanitas. Strong fluid nourishment should be administered, and an early change of air given. A subsequent plastic operation may be needed.

Noma.—A similar condition affecting the vulva. What has been said with regard to cancrum oris applies here.

Thermal Gangrene—Frost-bite.—A result of intense cold, whereby the circulation in parts exposed and far from the heart is arrested for a considerable period, leading to local death. It may also occur as the effect of reaction when parts which have been exposed to great cold are too quickly subjected to a reverse condition.

Symptoms.—There is no pain, but the area gradually becomes shrunken and hard, assuming a strange waxlike appearance, which goes on to discoloration, finally becoming black if the process is not

checked. In the reactionary variety there is great pain and a red congested appearance.

Treatment.—Cold water, or snow if handy, should be gently rubbed on the affected area till the circulation is restored. On no account should the patient be taken into a warm room or any hot application be applied to the part. Warm drinks may be given as reaction occurs, and the patient removed to a slightly warmer apartment. If gangrene supervene, asepsis must be secured and a line of separation waited for.

CHAPTER VII

SURGICAL INFECTIONS

Erysipelas—Cellulitis—Tetanus—Anthrax—Actinomycosis—Mycetoma—Glanders—Hydrophobia—Diphtheria—Tuberculosis.

Erysipelas.

An acute infective disease of skin or mucous membrane due to the action of a streptococcus which gains admission through an abrasion of the skin surface, though this is at times so small as to escape detection. The disease formerly attacked operation wounds, but it is rare to find it now associated with them, unless it be in one near the mouth. The organisms are chiefly found in the lymph spaces just beyond the line of the inflammatory margin, and it is here that the activity of the disease exists. At the inflamed margin there is a large number of leucocytes containing the micro-organisms. From this point to the centre of the affected area, where the tissues are practically normal, there are few organisms found, nor do they as a rule enter the blood-stream.

Symptoms.—The period of incubation is from one to two and a half days. Severe headache, nausea terminating in vomiting, with pains in the back and limbs, then come on; the temperature may rise as high as 105° F.; the tongue is very dirty, and there is marked constipation. Meantime the site of infection becomes of a dark, varying to light, red colour; there is a slight raising of the edges of the area. Blisters may form on the tense, glossy surface of the skin, and are found to contain the organisms. There is tenderness and even pain in the part, which is accentuated on handling; this is most marked a little beyond the red margin. Red lines round the area mark the lymphatic vessels; the deeper lymphatic vessels and glands are frequently enlarged and tender.

The duration of the disease varies according to the virulence of the attack and the resisting power of the patient. Occasionally death occurs from severe toxic infection, or from involvement of the brain and its membranes.

The face is the most usual situation in which to find the disease, and it is marked by very great œdema, which frequently closes the eyes; here there is danger of intracranial extension.

After a scalp wound in which there has been much soiling, erysipelas sometimes supervenes.

Complications.—Diffuse cellulitis with suppuration may occur in the course of the disease, such occurrence being looked upon as due to a mixed infection with other pyogenic bacteria.

Œdema may remain behind after erysipelas has been recovered from. It is solid, producing a type of elephantiasis, and is due to the obliteration of the lymphatic vessels. For this condition, which is troublesome, Sampson Handley has suggested the use of sterilized silk to form artificial lymphatics. The accompanying photographs, kindly lent by Mr. Sampson Handley, of a case of solid œdema of the arm and hand successfully treated by this method, show the condition before and after operation.

A puerperal type occurs in the genital organs, and an infantile one at the umbilicus ; both are serious.

Treatment.—With a view to stopping the progress of the disease, the skin surface beyond the tender zone, which is to be distinguished from the red margin, should be painted with liniment of iodine several times a day for about three days ; this produces a counter-irritation which antagonizes the action of the organisms.

Fig. 18.—Solid Œdema of the Arm and Hand.

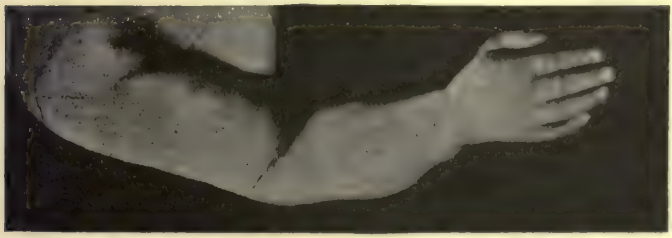


Fig. 19.—The Same after Lymphangioplasty.

To relieve pain and cover the affected area, the most useful application is ichthyol ointment or ichthyol paint covered with tissue-paper ; at the same time the strength of the patient should be kept up by fluid nourishment ; of drugs the most useful is sulphate of quinine in 2-grain doses administered at frequent intervals. Antistreptococcic serum is not uniformly successful, and in most cases it is unnecessary.

It is well to isolate cases of erysipelas, but not absolutely necessary if proper precautions can be assured without it.

Cellulitis.

A spreading inflammation of the cellular tissues, due in the milder cases to staphylococcic, and in the more severe to streptococcic, infection. Suppuration usually supervenes, and sloughing or gangrene may result. The organisms may gain entrance through a septic operation

wound, especially a deep one where drainage has not been effective. The smallest prick or scratch may, however, be sufficient to produce the condition, especially in those whose constitutional health is not good, or who are suffering from such diseases as diabetes or Bright's disease.

Symptoms.—These will depend a good deal on the situation, but, speaking generally, there will be tenderness of the part and slight malaise. Later there is great pain locally, together with heat, redness, brawniness, and subcutaneous suppuration; these local symptoms may increase enormously till spreading gangrene results. Meantime the constitutional symptoms are severe; there is high temperature, with rigors; the intense pain causes sleeplessness, which, together with the poisoning by toxic substances, rapidly reduces the patient's strength; occasionally the temperature is subnormal, owing to the depressing effects of the poison absorbed into the system.

Treatment.—For the earliest symptoms large fomentations of boric acid should be used locally, and iron and quinine given internally, while the bowels should be opened by saline purgatives. If these methods fail to stop the spread of the inflammation, free incisions are made into the brawny part, and the limb placed in a warm boric acid bath for some time, or in severe cases continuously, with a view to reducing the power of the toxins and washing them from the affected parts. When the limb is removed from the bath, the wounds should be lightly packed with iodoform gauze, with a view to further draining the part, and dressed with Gamgee tissue and mackintosh. Where the bath cannot be used, and in milder cases, the incision wounds should be at once dressed in this way. The strength of the patient should be kept up with a good slop diet, and the bowels gently opened, purgation being avoided. Antistreptococcic serum, 10 c.c., may be tried, but the results following its use have not been very encouraging.

Varieties — Ludwig's Angina. — This is a submaxillary cellulitis, named after the surgeon who first described the variety. It involves the cellular tissue beneath the deep cervical fascia, and usually occurs in weakly subjects. There is apparently no special reason for it starting, but it is thought that the originating cause is a wound which becomes foul in the mouth cavity. It shows itself as a brawny, tender, hot, and painful swelling in the submaxillary region, which tends to spread upwards and forwards, making the tongue protrude in bad cases. Symptoms of a dangerous nature may ensue, owing to pressure on important structures; pyæmia may follow venous thrombosis. Suppuration, with sloughing of the tissue, usually results; this should be limited by a free incision into the affected area wherever it is safe to make it. The usual preliminary treatment should be adopted to try and avert suppuration.

Pelvic Cellulitis.—This usually arises from within, and is secondary to inflammation of one or more of the pelvic viscera, spreading therefrom to the loose cellular tissue without. The condition is most common in the female. The signs and symptoms of a deep-seated inflammation are present, and peritonitis is often set up. A swelling is felt, *per rectum* or *vagina*, which is tense and painful, while above the arch of the pubes an indurated mass may at times be felt, which gives a dull note on percussion. If an abscess forms, it may point or burst externally or internally, sometimes in both directions, giving rise to urinary

and fæcal fistulæ. Intestinal obstruction and hydronephrosis may develop later from cicatricial contraction or pressure.

The treatment consists, in the early stages, of rest, dieting, fomentations over the site of inflammation, and frequent hot rectal or vaginal douching. When pus has formed, a careful dissection is to be made down to the site of the abscess from a point above Poupart's ligament and near to the pubic spine. The abscess should be carefully drained, a counter-opening being made if necessary.

Cellulitis of the Orbit.—This often follows deep wounds in the region, no doubt from the difficulty experienced in rendering them quite aseptic. The eyeball is thrust forwards owing to the swollen condition of the tissues, and the lids become œdematous. Grave trouble may arise here from the involvement of the membranes of the brain, disease of the bony wall, or involvement of the eye. The treatment to be adopted is to open up the old wound, if possible, or to make a fresh one through the lids or the fornix, after which antiseptic fomentations should be applied.

Cellulitis of the Axilla, Scalp, and Submammary Regions.—These call for no special mention, and are to be treated on general lines, as already laid down.

Whitlow.—This term is applied to an acute, painful, infective condition of the fingers, and occasionally of the toes, produced as a rule by a trifling injury, such as a scratch or prick. It is a septic condition, and is usually followed by suppuration. The various types described merge into one another, so that clinically we cannot often discriminate one from the other, unless in the case of the variety in which the suppuration is beneath the periosteum. Theoretically and for examination purposes we recognize the following varieties :

Subcuticular.—This is a mere spot of pus under the cuticle, which, however, is very painful. The surface of the skin over the pus should be clipped off, and a boracic fomentation applied.

Suppuration of the Nail Root.—Here the pus forms under the root of the nail. The condition is intensely painful, giving rise to considerable constitutional disturbance. To relieve the pain by liberation of the pus it is necessary to cut away a portion or the whole of the nail.

Subcutaneous.—This is a cellulitis of the pulp of the finger, which often spreads to and involves the palm of the hand. The finger becomes very painful and swollen. The swelling is hard, and it may be difficult to elicit fluctuation. The presence of pus can, however, be deduced from the swelling, redness, and acute pain.

A free incision, **not, however, opening the tendon sheath,** should be made after an initial boric fomentation has been applied, which it is often well to repeat afterwards to relieve pain, and insure the complete removal of any suppurating points.

Thecal.—This is a teno-synovitis of the flexor sheaths accompanied by suppuration. The form is characterized by great pain, especially on bending the fingers, and by marked swelling, which often extends to the dorsum. It should be remembered, on account of the arrangement of the tendon sheaths, that in the case of the thumb and little finger there may be direct extension of the trouble into the forearm. In the case of the other three fingers it will only extend to the forearm

after invading the palm. Early and free incision is here most important to prevent extension or adhesions.

Subperiosteal.—Occurs as an extension of the thecal variety, or as a necrosis of the terminal phalanx. A free incision should be made, and the bone, if dead, removed.

Tetanus.

An infective disease due to the action of the *B. tetani*, which gains admission by a broken surface. The occurrence of idiopathic tetanus is now discredited.

The nerve-centres are principally affected, the poison travelling to them from the original site of infection by the motor fibres, and producing a hypersensitiveness in the motor ganglia of the cord.

Symptoms.—The common name of "lockjaw" applied to tetanus is derived from its outstanding symptom, but the student must not be deceived into making the mistake of assuming that the terms are synonymous. The spasm of the masseter muscles is but a symptom, though a prominent and early one, of the general condition of spasm observable, which really starts in those muscles near the focus of infection. Following these and, as a rule, the first affected in the patient's estimation are those of the neck, then, in order, the jaw, the facial muscles, the diaphragm and abdominal muscles, those of the thorax and back, and, lastly, those of the limbs. This is the usual order, but it may be varied; nor are all these muscles necessarily affected.

There is pain associated with the stiffness. The term *risus sardonicus* is applied to the expression produced by the angles of the mouth being retracted. The tonic is succeeded by clonic spasm, which becomes more and more severe, the violence at times being so severe as to rupture a muscle or fracture a bone. When the back muscles are contracted, the body may rest on heels and occiput, producing the condition known as *opisthotonos*.

The constitutional symptoms associated with the muscular spasm are, a temperature of 100° to 102° F.; occasionally it remains normal, while before death it may run up to 110° F., and after death go up still higher. The pulse-rate is raised, and during the spasms becomes more rapid, and as a fatal end approaches it may become very rapid and feeble. The respiration is especially affected when the muscles of the thorax are attacked, and a feeling of suffocation adds its terror to an already most distressing disease. There is **profuse perspiration,** with diminished secretion of urine; occasionally the urine has to be removed with a catheter, owing to spasm of the muscles of urination preventing the evacuation of the bladder.

A fatal termination may occur during spasm, especially of the diaphragm, or may be ushered in by the relaxation of exhaustion.

The incubation period may vary from four to twenty-one days; the shorter the period, the more severe the type. In the less severe variety, which is sometimes called "chronic," to distinguish it from the very acute, trismus, or lockjaw, is the most constant form of spasm present.

According to the length of the period of incubation, the condition of the original wound will vary from being soundly healed to being sloughy and painful when the disease develops.

Diagnosis.—Tetanus has to be distinguished from **strychnine-poisoning** by the symptoms of the latter following the ingestion of

the drug or food containing it, by the spasms, which are clonic from the beginning, being more intermittent, the muscles being completely relaxed between the fits, and by the spasms ceasing when the dose is not a fatal one. From **hydrophobia** by the history, by the spasm being clonic from the beginning, and by the muscles principally affected being those of deglutition and respiration. From **hysteria** by the history of the case, observation of the patient, and the effect of remedies.

Treatment—*Local.*—The wound should be thoroughly cleansed, the unhealthy parts being cut away, and the whole surface swabbed with pure carbolic acid.

Constitutional.—The patient should be kept in a quiet room. To prevent convulsions and combat rigidity, chloral, 150 grains spread over twenty-four hours should be given by the mouth or rectum, or chloretone in 30-grain doses, should be administered by the rectum, with olive oil as a vehicle. To relieve convulsions, chloroform is useful. A high temperature is relieved by sponging, which also calms the patient.

Serum Treatment.—The benefit is not very clearly proved, since its use in chronic tetanus does not show that recovery is due to it, there being frequently spontaneous cure in such cases. In acute cases, unhappily, it does not seem to have been uniformly very beneficial; still, it should always be employed. The antitetanic serum should be injected early and in one large dose—60 c.c.—followed by smaller ones. It is said that the best position for such injections is into the nerve trunk leading from the focus to the spine, and that better results follow when the serum is used early, before the toxin has reached the place of injection.

If a person is suspected of having been in contact with the poison, an injection of 10 c.c. into the muscles of the buttock may be of benefit as a preventive treatment.

Anthrax.

Anthrax, or woolsorter's disease, is due to infection with *B. anthracis* through a scratch of the skin, by inhalation, or through the stomach; the latter is the mode of infection in cattle. Hides, skins, hair, and wool, which have become smeared with blood, retain the property of conveying infection for long periods after drying.

Symptoms.—At the site of inoculation a red pimple appears, which soon changes into a vesicle, and rapidly develops into a *malignant pustule*, consisting of a dark centre surrounded by numerous vesicles. This is the usual method of attack in man, and there is little pain or constitutional symptoms unless in a case running to a fatal termination, when there is high temperature, quick pulse, shallow and embarrassed respiration, and finally delirium and coma. In the pulmonary variety of the disease there is high fever, great dyspnœa, and a sero-fibrinous pleuro-pneumonia develops, which runs a quick course, as a rule to a fatal ending. *Diagnosis* may be made by examination of the sputum for the bacillus. In the gastric form of the disease there is colic, vomiting, and blood-stained diarrhœa. This type, which is really intestinal rather than gastric, is not so fatal as the pulmonary. When the condition is a general one without external lesion, the term *anthracæmia* is applied to the disease.

Diagnosis.—Malignant pustule is very characteristic, and cannot well be mistaken for anything else; but in the varieties with constitu-

tional symptoms it is always well to seek for confirmatory diagnosis by bacteriological examination of the secretions or excretions.

The trades usually affected are graziers, butchers, and workers in hides or wool.

Treatment—*Local.*—Excision of the malignant pustule or necrotic patch and of the neighbouring tissue, and the application of pure carbolic acid or the actual cautery. Some advocate leaving the pustule, but this appears irrational.

Constitutional.—Stimulating food, quinine, or ipecacuanha in large doses, 10 grains and 40 grains respectively.

Serum.—Injection of 40 c.c. of Sclavo serum at an early date gives good results. It acts by stimulation of phagocytosis rather than as a neutralizing agent to the toxins.

Actinomycosis.

This disease is sometimes found in cowmen, who contract it by inoculation from cattle affected with the ray fungus (*Streptothrix actinomyces*). It may also be contracted by inhaling the spores mingled with the dust during the process of corn-grinding. It may thus be classed as an industrial disease, and sufferers therefrom establish a claim to compensation, since actinomycosis is in no way *incident* to the work of a cattleman. In opposing such a claim, it may be stated that the disease is often due to chewing or eating fresh corn, the person being thus infected by direct inoculation with the fungus.

Symptoms.—The disease is one which may attack widely different regions. In the tongue and maxilla it gives rise to diffuse induration and suppuration; in the lungs to lesions which resemble those of **tuberculosis**; in various parts of the intestines, especially the cæcum, to suppuration, when the condition simulates **appendicitis**; in the liver to swelling, with diffuse suppuration; in the skin to the formation of numerous globular masses, soft and spongy, with an indurated base. The pus in all the lesions is very characteristic, containing as it does a number of **yellow granules**; these are small masses of the fungus. The disease, as a rule, runs a chronic course, but is not in itself dangerous, unless involving internal organs, or by reason of septic poisoning being superadded.

Treatment.—Free removal of the affected parts and the subsequent cauterization of the wound by the actual cautery or carbolic acid. X-ray treatment has proved of benefit in some cases, and also that by vaccine prepared from cultures of the micro-organism. With the former treatment it is well to use large doses of the iodides or injections of cacodylate of soda in 10 per cent. solutions.

Mycetoma.

A chronic disease, characterized by a gangrenous condition of the foot (Madura foot), and caused by a micro-organism which bears a strong resemblance to that of actinomycosis.

Symptoms.—The disease begins as an indurated patch, which gradually becomes spotted with black and yellow nodules. These spread and become suppurative, finally forming small multiple abscesses, in the pus of which are found yellow and black pigmented granules. The foot becomes deformed and disorganized as the bones are affected with caries or necrosis, the deformity being a flattening of the

sole, with dorsi-flexion of the toes. The disease often extends up the leg. There is little local pain or constitutional disturbance.

Treatment.—This consists in early amputation well above the disease. Conservative and drug treatment are of little or no avail ; nevertheless the disease is very chronic, and only kills by prolonged suppuration.

Glanders.

This disease is most common in the horse, and is usually communicated to man from that animal through an abrased surface of the skin of hands or face, or of the mucous membrane of the mouth, nose, or eye.

It is due to the action of the *B. mallei*, which organism is distinguished from the tubercle bacillus, which it resembles, in being shorter and broader, and in not staining by Gram's method.

Symptoms.—As it occurs in man, the disease is more usually of the acute type. There is pain, swelling, and redness of the infected wound. In about a week several small nodules appear, which quickly become pustular. When these occur on the face, they may possibly be mistaken for the pustules of smallpox. They run together and break down, making irregular ulcers, with extensive destruction of tissues. When the mucous membrane of the nose is affected, there is a watery discharge, which soon becomes sanious, and then purulent. If the bones of the nose become necrosed, the discharge is very foul Later metastatic abscesses form. Meanwhile the temperature is raised to 104° or 106° F. ; there is severe headache, and the pulse is rapid and weak. Sweating is marked ; the urine contains albumin, and delirium is frequently present. A fatal termination is common, and usually occurs in the second or third week.

Man may be affected with the more chronic type of the disease, known as *farcy* when occurring in the horse. Here the features are a lymphangitis, with nodular thickening of the lymphatics (farcy buds), while the neighbouring glands are enlarged and hard. The focus of infection becomes inflamed and breaks down, and later on the glands also become suppurative ; secondary deposits in muscle and elsewhere sometimes occur. The disease may run a course of several months' duration, and recovery takes place in about half the cases.

Diagnosis.—The disease is often hard to identify, but the case can usually be cleared up by the history of contact with the disease in horses, and by the recognition of the organism.

Treatment.—General tonic treatment and the excision of the local manifestation, with cauterization of the wound.

Hydrophobia.

This disease, most commonly met with in the dog, and transmitted to man from that animal by means of a bite or lick on an abraded surface, is, fortunately, almost unknown in this country now, owing to the wise dog quarantine introduced some years ago.

The disease is probably due to a specific micro-organism, which has not, however, yet been isolated. The nervous system is profoundly affected by the poison, and the nearer the brain the infection occurs the earlier will the symptoms develop.

Symptoms.—The incubation period varies from two weeks to eight months. The wound has probably healed before any symptoms occur. There is a few days of malaise, with shivering and giddiness ; then the

patient begins to catch his breath, owing to spasm of the diaphragm. The spasm rapidly spreads to the muscles of respiration and deglutition, these being the ones chiefly affected in the disease. There is a plentiful secretion of saliva. Any muscular effort or any external stimulus increases the spasm, which is also aggravated by attempting to swallow fluid. There is rise of temperature and increased pulse-rate. The mental symptoms are distressing, being those of fear and despair, while the mind as a rule remains clear. Death usually results in a few days.

Treatment.—When once the disease is established, nothing, so far as we know at present, can be done to avert the fatal termination. The treatment resolves itself into diminishing the spasms. Immediately after the bite of the suspected animal, the wound should be cauterized, but no faith can be placed in this treatment if the animal is proved to have rabies. The patient should immediately undergo the **Pasteur preventive treatment,** which consists in immunizing by inoculation with a modified virus. The strength of the virus is gradually increased during the course of preventive inoculation.

The suspected animal should never be killed until its condition has been proved to be due to rabies, when it should be slaughtered, and the brain and spinal cord carefully examined.

Diphtheria.

This infective disease, due to the *Klebs-Löffler bacillus*, does not concern the surgeon, except in that it sometimes occurs in operation and other wounds through infection carried from another patient, and that his services were formerly frequently required in the performance of tracheotomy, for the relief of laryngeal diphtheria. Such a procedure is not often called for now, if antidiphtheritic serum has been used sufficiently early and in large enough doses.

Tuberculosis.

By this term is meant the various conditions which are produced by the action of the *tubercle bacillus* in the tissues of the body. The term *phthisis* is reserved for pulmonary tuberculosis, which is a common variety of the disease, but comes under the domain of medicine rather than of surgery.

Surgical tuberculosis is most commonly met with in lymphatic glands, bones, and joints, and frequently in the kidney, testis, the peritoneum, and intestine, and in the skin and subcutaneous tissue. It may, of course, be met with in any other tissue, but is not common in some organs—as the ovary, pancreas, thyroid, and parotid—and seldom is it found that tuberculosis attacks a wound on the surface of the body, this being in marked contrast to those surgical diseases of infective origin already considered.

There is no disease in which inheritance and environment play a more important part than in tuberculosis. Take a child born of tuberculous parents, and place him in hygienic surroundings, and the probability is that he will never develop the disease ; while if a child born of healthy parents be placed from infancy amidst bad hygienic surroundings, the probability is that at some time he will develop the disease in one or other of its forms.

It is now generally held that a predisposition to tuberculosis rather than the disease itself is handed down from father or mother to son or daughter.

Osler states, after quoting Baumgarten's views on the congenital origin of the disease: "Against Baumgarten's theory are the facts that the percentage of cases of congenital tuberculosis is extremely small, and, in the great majority of instances, the organs of fœtuses born of tuberculous mothers give negative results when inoculated into guinea-pigs."

The cases are so few and the evidence so doubtful of the disease being transmitted that it seems much more likely—indeed, certain—that it is not the transmission of the bacillus, but of an inferior and poorly resisting tissue, the result of the action of the bacillus on the parent, that is to be dreaded in the children of tuberculous subjects.

Bad results following accident are more marked in the tuberculous than in any other subject. The injury may be looked upon as determining the position of the lesion in one in whose blood the tubercle bacillus is present rather than the real factor in its production.

Baumgarten believed that the bacillus lay dormant in the tissues of the children of tuberculous parents, and developed when the resisting power was lowered. This was mere assumption. What does seem to be certain is that, whether as the result of the actual bacillus being present in the tissue, or only from the fact of the tissues being of a poorly resisting type, tuberculosis results, when from any cause the opsonic index is further lowered.

It is here that accident plays such an important and unfortunate part. A trifling injury, which would have little or no effect on the healthy individual, produces a long train of disastrous results in the hereditary weakling born of tuberculous parents—results which lead on from one stage of suffering to another, too often resulting in deformity or death.

Modes of Infection.—If it be taken for granted, then, that the bacillus is not present in the tissues at birth, and that trauma is merely a determining agent in those who already have the tubercle bacillus circulating in the blood, it remains to be ascertained how the organism gains admission and whence it comes.

In most cases the path of entrance is the **respiratory** or **digestive** tract. Healthy and predisposed are alike subject to the entrance of the organism, especially in great centres of population; for it is constantly in the air, being given off from the dried expectoration of tuberculous persons. Since sunlight and fresh air are the most potent agencies for the destruction of the bacillus, it may seem strange that the danger should lurk thus in the open. The reason is that the organisms are frequently inhaled or swallowed before there is time for their destruction by air and sunlight; especially is this true in more or less confined spaces where people congregate, such as tramcars and railway-trains. There exists another origin of infection, and that is from the dried pus and dressings of patients suffering from some form of surgical tuberculosis, especially in the dwellings of the poor.

The mucous membrane lining the **air-passages** from the nose and mouth to the fine bronchi of the lungs is constantly exposed to infection by the dust laden with bacilli which is inhaled; but it does not follow that the organism obtains a footing or is lodged in any of the glands, for the perfectly healthy and non-predisposed body is quite capable of overcoming the invasion. If infection takes place, it frequently develops in the form of pulmonary tuberculosis, with which the surgeon has little to do. Lodgment, however, may be effected by the bacillus in the tonsils and pharyngeal lymphoid tissue, and pass through the

lymphatics to the glands, those most frequently affected being the cervical and the bronchial glands at the root of the lung. After lodgment of the organisms in the glands, one of two things may occur: either there is early evidence of their presence by enlargement, induration, and breaking down, or they may be quiescent for a considerable time, till, owing to some lowering of the person's general health, they become active. The tissue then becomes softened, disintegration takes place, and the organisms gain entrance to the general circulation by the disease causing erosion of a neighbouring vein. Once in the blood-current, the organisms may be carried and lodged in any particular part of the body, perhaps predisposed to such lodgment by local lowering of tone produced by accident; or general tuberculosis may be set up.

The mucous membrane of the **digestive tract** is liable to be infected by swallowed sputum, by food containing the bacillus, or by transmission through the blood-stream from the lungs. Milk and tuberculous beef are the foods most liable to carry the infection. It seems fairly certain that the milk of cows suffering from tuberculous disease of some particular organ contains the tubercle bacillus, as well as that from cows with tuberculous udders. Beef, if well cooked, is probably harmless; but it may happen that tuberculous beef is prepared for consumption in such a way that the tubercle bacillus is not destroyed.

Tuberculosis of the digestive tract occurs most frequently in the intestines, and there in the ileum, cæcum, or colon. **Primary** infection is most common in children, probably owing to their largely milk diet; **secondary** infection, occurring as pulmonary tuberculosis, in adults. In some cases tuberculous infection of the intestines is secondary to disease of the peritoneum.

The organism may—(*a*) Lodge in the mucous membrane, and give rise to tuberculous ulcers, which are usually round, and diagonal to the long axis of the bowel; in the ileum the ulcer may be ovoid. (*b*) Pass through the wall, and be carried by the lacteals to the mesenteric glands, giving rise to tuberculous processes in them. From these glands there is danger of the blood-stream becoming infected directly or through the thoracic duct; or, again, tuberculous peritonitis may be set up by direct contagion from a degenerated gland.

Formation of Tuberculous Nodule, or "Tubercle."—The organism is carried to an area of lowered vitality, where probably the circulation is slow, the disease frequently beginning in or around the small vessels. Its lodgment causes a chronic form of inflammation, which produces overgrowth of the endothelial elements, and may be followed by proliferation of the connective tissues, and their infiltration by leucocytes leading to obliteration of the circulation in the part, and the formation of a tubercle which is formed of a central giant cell with nuclei. Round this is a network containing a large number of epithelioid cells derived from the connective tissue; outside this zone is a layer of smaller cells, probably leucocytes; these merge into the surrounding tissues, which gradually take on the form of granulation tissue. This is apt to undergo a form of degeneration and death, which is called "caseation," and is characterized by the formation of a pale yellow, cheesy substance. Calcification of this material may later take place by the deposition of lime-salts.

It must not be supposed that all tuberculous processes have this definite formation, as the process may be diffuse, and frequently no giant cell is present. The "tubercle" is a dead mass characterized by the absence of circulation.

The **Symptoms** of tuberculosis are so various according to position and the tissue attacked that their description will be left to be described when treating of the various regions in which the disease occurs.

Diagnosis.—Apart from the physical diagnosis, to be considered with the parts affected, there exists the method by the use of **tuberculin,** which will be considered here.

The original test was the injection of a concentrated extract of dead tubercle bacilli, which, when given to one suffering from tuberculosis, was followed by such severe reaction as to constitute a danger, and so this was given up in the human subject, but is retained for diagnosing the disease in cattle. For diagnostic purposes in man the following modifications are used :

1. *Von Pirquet's Cutaneous Reaction.*—The inner aspect of the forearm is scratched with a needle or the point of a lancet, and a few

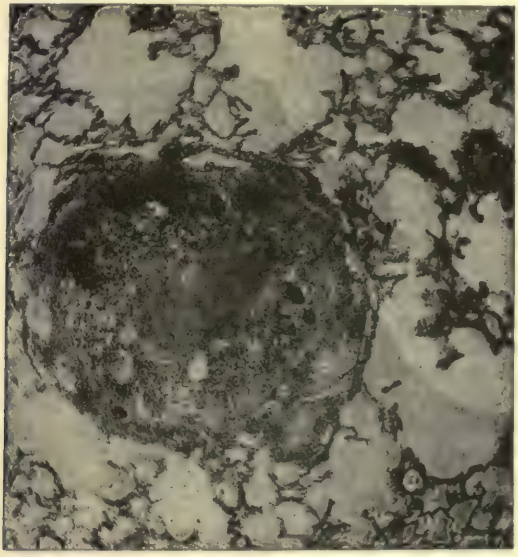


FIG. 20.—NODULE IN CHRONIC TUBERCULOSIS OF THE LUNG.
(Beattie and Dickson.)

drops of Koch's tuberculin, diluted 25 per cent., is rubbed in ; another similar inoculation is made at a little distance from the first. If the patient be tuberculous, a papule will appear in from six to twenty hours, which will increase in size till in forty-eight hours there is a raised and hyperæmic papule surrounded by an area of bright red. The method is simple, and causes no constitutional symptoms.

2. *Calmette's Conjunctival Reaction.*—This consists in putting a drop of a special tuberculin solution into the inner angle of the eye. If the patient be tuberculous, smarting, lachrymation, and conjunctival redness is produced in a few hours, and lasts for about twenty-four hours. Care should be taken that the eye is quite normal when the test is applied. The solution used is prepared by purifying the tuberculin by repeated precipitations in alcohol, and drying *in vacuo ;* it is then redissolved in normal saline solution, so as to make a 1 per cent. solution.

3. *Opsonic Index Test.*—This consists in injecting $\frac{1}{2000}$ milligramme of Koch's New Tuberculin, and subsequently taking the tuberculo-opsonic index of the blood.

Treatment.—Tuberculosis is an eminently curable disease when taken in time and properly treated. The best mode of fighting the tubercle bacillus, in common with many others, would appear to be the improvement of the resisting power of the body rather than by the action of a direct germicide, even were it not a matter of great difficulty to get such an agent into direct contact with the focus of disease.

It is therefore of great importance that the general health and strength of the patient should be improved, and with this object good air, sunlight, and plentiful good food should, as far as possible, be provided. The open-air treatment is now recognized as being serviceable when cases come under observation sufficiently early. A sea-voyage, formerly so often recommended, is good when proper cases are chosen, but should not be advocated indiscriminately owing to the possible discomforts and sea-sickness encountered. The following extract from the author's book, "Sea-Sickness: Its True Cause and Cure," may be quoted aptly in this connection:

"Many cases are met with where great prostration has to be faced; others where severe hæmoptysis threatens phthisical patients. I would here draw attention to the very serious condition to which such patients may be reduced who are often thoughtlessly ordered abroad for their relief or cure. There is a change in this respect, but many are still sent on long sea-voyages who could be much better treated in a sanatorium at home.

"Cases are often seen of those in the second and even third stages of phthisis, who have been enabled to take the voyage with much financial difficulty, and have to make it as one of three or four in a small third-class cabin. Such patients, often unable to touch the food—good, but rather coarse—are particularly bad subjects should the ship encounter rough weather. They are usually violently ill, and have to remain in lower-deck cabins, with every porthole closed. The atmosphere of such a cabin teems with tubercle bacilli and other forms of germ-life inimical to health. The result is that the unfortunate patient lands, if he survive, on some distant shore a piteous wreck, friendless, probably almost penniless, in every way worse than when he left England, having on the journey probably caused infection to more than one cabin-mate.

"The only class of patient with pulmonary tuberculosis who should be allowed to go for a long voyage on a passenger-ship is one in the first stage of the disease, who can afford to have an entire first or second-class cabin, with plenty of air-space, to himself. If bad weather be met with, fair ventilation can then be secured. This minimizes the risk of sea-sickness for the patient, and danger to others is avoided.

"For those suffering from many forms of surgical tuberculosis, a sea-voyage is of benefit when the disease is not too far advanced, and in these cases the risk of infecting others is much less than in the pulmonary variety of the disease."

Foods rich in proteid matter and fats should be taken, but it is unfortunate that many tuberculous patients are averse to fatty foods. Milk, however, is usually tolerated, and is probably the best of all

foods for the tuberculous patient, though the one most frequently responsible for the disease. If, therefore, the source of the supply is not above suspicion, the milk should be sterilized. Cod-liver oil is a valuable food-medicine, and may profitably be combined with small doses of carbonate of guaiacol ; Scott's Emulsion is an excellent form in which to prescribe the oil for intolerant stomachs. Underdone meat free from taint is a valuable food for the tuberculous subject, but the tapeworm must be guarded against. Tonics are sometimes called for, when iron in the form of the syrup of the iodide will be found of service.

Germicidal Method of Treatment.—It has been thought by some that the intravenous injection of some drug with a view to killing the organism is of distinct benefit, and formaldehyde and chinosol have been used for this purpose. Even if this method were to get rid of the organisms circulating in the blood, it does not deal with those latent in the glands or elsewhere, the tubercles being almost devoid of circulation, and the tissues surrounding deprived of germicidal power.

Vaccine Treatment.—The injection of a small dose of Koch's New Tuberculin is followed by lowering of the opsonic index, which is succeeded by a rise beyond the initial position, indicating that the lowering of the bactericidal power of the blood is only temporary, and is followed by an increased power of resistance to the tubercle bacillus, which lasts for about a fortnight. The first injection may be repeated after this interval, and the effect prolonged by further injections. It may be necessary to remove inert masses of tuberculous material, or to drain or remove by counter-irritation tuberculous ascitic fluid in order that the protective fluids may have free circulation. For further particulars, see Chapter III. and Appendix.

Bier's Hyperæmic Treatment.—This method of treatment and the details of its application have been already considered under Inflammation. Either the bandage or Klapp's suction bells are employed, according to the situation ; obstructive hyperæmia is aimed at in the tubercular lesions, never hot air. Many cases formerly treated by operation are now known to be curable by Bier's method, though, of course, longer time is required, and frequently minor operative treatment, in order to remove inert masses of material before the hyperæmic method is begun.

In the treatment of most tuberculous lesions, and especially where joints are involved, rest to the part is an invaluable consideration.

Tuberculous Abscess (Cold or Chronic Abscess).—Here there are no signs of an acute infection, but a soft, more or less fluid tumour or swelling caused by disintegration and liquefaction of tuberculous granulation tissue which has become caseated. The contents, according to the presence of many leucocytes from the neighbouring bloodvessels, or of fluid exudate, and the extent of the process of disintegration and liquefaction, may vary from ordinary-looking pus to clear amber-coloured fluid, or thick, cheesy material. The latter is held to be most "tuberculous" in character. The wall has a lining formed of tuberculous granulation material in varying stages of disintegration, and has a shreddy character. A tuberculous abscess increases by continual breaking down of fresh tissue, and may extend, according to the anatomical arrangement, to a distant part before coming to the surface, as the psoas abscess, which, beginning as a rule in the dorsal vertebræ

of the spine, may travel down the sheath of the psoas muscle, and thence to point in the thigh.

It should be distinctly remembered that a tuberculous abscess is not septic, but usually becomes so by soiling from without, so that great care should be exercised in its treatment. When it becomes hot, red, and painful, then it may be concluded that there is a mixed infection, and that pyogenic organisms have gained admission. When this takes place, the danger to life, which is not great from an ordinary tuberculous abscess, is increased by the supervention of hectic fever, septicæmia, or by increasing the possibility of general tuberculosis. The diagnosis of the abscess is not likely to be very troublesome if we pay attention to the history and the presence of tuberculous disease in the neighbourhood of the formation. It may possibly be mistaken for a lipoma, a cyst, or a gumma.

Treatment.—When the abscess is spreading or is in danger of bursting, active treatment should be adopted. This may consist in—

1. Simple aspiration.

2. Aspiration, plus injection of 10 per cent. iodoform in glycerine or ether. This solution acts by the liberation of iodine which counteracts the influence of the bacillus, and helps in the production of healthy granulation tissue. It is injected by means of a glass-barrelled syringe screwed on to the cannula which has been used to evacuate the pus. In passing the trocar and cannula, healthy tissue should be chosen for the site of the puncture.

3. Incision. A fairly large incision is made, and the lining membrane gently scraped with a Volkmann's spoon; all débris should be removed, and any bleeding stopped by pressure; iodoform powder is then well rubbed into the raw surface, after which the tissues are firmly sutured together in layers, if the abscess be a deep one. If there is a probability that the abscess is caused by mixed infection, and when it is a small superficial one, the cavity should be packed with iodoform gauze, and left to granulate. Any unhealthy skin should be removed at the time of operation.

4. Suction by means of Klapp's glasses. This is suitable when the abscess has already been perforated, and where there is mixed infection, and also in an abscess caused by a breaking-down gland; a small incision should be made and the suction-glass applied regularly.

Tuberculous Ulcer.—This is generally the result of an abscess bursting through the skin. The shape is irregular; the surrounding skin unhealthy; the edges undermined, blue or purple in colour, and ragged; the base is sloughy, or covered with pale, unhealthy granulations.

Treatment.—Removal and skin-grafting for small ulcers. Tuberculin, X-ray or Bier's method for larger surfaces, together with general constitutional treatment.

CHAPTER VIII

TUMOURS

Definition—Causation—Clinical division: *Innocent* and *malignant*—Anatomical division: *Connective-tissue* and *epithelial tumours*—Description of tumours—Dermoids—Cysts.

A tumour, neoplasm, or **new-growth,** is a **mass of new formation which tends to grow or persist, without fulfilling any physiological function, and with no typical termination.** This definition excludes the congenital overgrowth called **gigantism,** since it is not a new formation, but an enlargement of normal tissue. Neither does it include inflammatory overgrowths, since they leave a definite termination. Pure hypertrophies are also excluded, as they fulfil a physiological function.

Causation.—This is not clearly understood, but the following may be taken as probable.

Cause.	Mode of Action.	Examples.
Congenital ..	Owing to malformation of the tissue from which they spring	Angiomata, chondromata, osteomata, adenomata
Cohnheim's fœtal residues	"Rests," or "Residues," are embryonic cells which remain in fully formed tissue till excited to active growth	Dermoids, etc.
Local irritation	Appears to play a part in the production of tumours met with in skin and mucous membrane, probably by lowering the vitality of the part in a predisposed subject, and thus inducing action of whatever agent is concerned as an exciting cause, to stimulate fœtal remains to growth, or to alter the character of an existing tumour and hasten its growth, or to start tumour growth *de novo*	Cancer of skin, lip, and tongue
Radiations ..	Attention has been lately drawn by Lazarus-Barlow to the place which radiations, especially radium radiations, may hold in the production of neoplasms. The mode of action is the stimulation of cell development by the force of the velocity of the rays. This may prove to be the long-sought agent of the production of cancer	The carcinomata which are found to contain radium, which, though it may be present in normal tissues, is in much smaller proportions
Heredity ..	Constitutional predisposition, owing to greater tendency to tissue change and tumour formation as a result of local irritation, injury, etc.	Cancer, osteomata, lipomata, especially the latter two

Clinical Division of Tumours.

Perhaps the most useful division for the student of surgery to understand and remember is the broad clinical one of **innocent** and **malignant,** for on this division will largely depend the prognosis and the treatment of the case.

The innocent tumour is capable of satisfactory local treatment, since it is local in its character and effects. The malignant tumour, unless in very early and favourable cases, is not so, its effects being constitutional and general as well as local, and its tendency is marked to spread and produce secondary local manifestations, which may ultimately cause death.

Innocent, or Benign, Tumours.—These tumours in their structural character are closely allied to the normal tissues. They are circumscribed and surrounded by a fibrous capsule, from which they can be enucleated. Their rate of growth is slow, and in it they push aside, but do not enter or infiltrate the adjacent parts. By pressure on important organs they may be a danger to life, but only in this way, since they produce few constitutional symptoms and do not return after removal.

Malignant Tumours.—In contradistinction to innocent ones, malignant growths are different in structure to the normal tissue of the body. They are of a less highly developed form, though their cells are derived from normal-tissue cells. **Altmann's granules** are absent from the essential cells of malignant growths, while they have been shown by Beckton to be present in all varieties of cells met with in inflammatory tissue. This is a valuable point in diagnosis. Malignant tumours multiply at the expense of the normal tissue, and destroy the structures they grow amongst. Their **growth is more rapid** than innocent tumours; they are **not encapsuled,** but have outgrowths which render a radical removal difficult when once they have penetrated the surrounding tissues. They may spread to different parts of the body by the lymph or blood-stream. They tend to become fungoid by involving the overlying skin. Constitutional symptoms are marked, and a condition known as **cachexia** is set up produced by pain, exhaustion, anxiety, and depressions, chronic toxic effects, and interference with the normal functions of the body.

The signs of this condition are progressive, and sometimes rapid emaciation, sallow complexion, profound depression, an anxious countenance, and a certain amount of feverishness.

Life may be destroyed by progressive constitutional disturbance or by some local condition, as hæmorrhage or septic infection.

The **Prognosis** of malignant disease differs much; thus, at one extreme may be cited **rodent ulcer,** which is a local manifestation and seldom kills, and at the other **melanotic cancer,** which is rapidly fatal. Again, age, rapidity of growth, and the position of the tumour, will influence prognosis; thus, a slow-growing cancer—say of the breast in an old thin woman—may not interfere with length of life.

We may tabulate the more important differences between innocent and malignant tumours as given in the table on p. 125.

It should be remembered that the type of a tumour may change from innocent to malignant; whether in order to do so there is of necessity predisposition is not proved, but it would seem probable, in view of the fact that in many cases innocent growths may be exposed to

irritation, and yet remain innocent, while in other cases they become malignant. It is always wise to advise the removal of an innocent growth, especially if exposed to irritation or liable to injury.

	Innocent.	Malignant.
Structure	Similar to that from which they spring and are found amongst	Distinct in type from normal tissue
Rate of growth	Slow	Usually rapid
Capsule	Present	Absent
Recurrence after removal	Unusual	Common, unless removed very early
Involvement of surrounding structure	None	Common
Involvement of distant parts	None	Common by means of lymph or blood-streams.
Number	Sometimes multiple	Rarely multiple
Constitutional symptoms	Slight or absent	Severe

Anatomical Division of Tumours.

Tumours are divided anatomically as well as by their clinical manifestation. The table on p. 126 gives this division, and also indicates their clinical significance.

FULLY DEVELOPED CONNECTIVE-TISSUE TUMOURS.

Description of Tumours.

Lipoma.—A tumour composed of fat arranged in lobules with connective-tissue septa continuous with its capsule, and attached to the skin, which is often dimpled.

Characteristics.—Soft, **lobulated,** slow-growing tumour of varying size, with dimpled skin, demonstrated on trying to pinch it up.

Common Situation.—Shoulder, buttock, back. Less common in neck, axilla, and pubic region as **diffuse lipoma** (**lipomatosis**). Also as periosteal subserous (**fatty hernia**), subsynovial, and muscular lipomata.

Treatment.—Shelling out by dividing skin and capsule when practicable.

Xanthoma.—This sometimes deserves the name "tumour," and may become disseminated. It occurs in the skin chiefly of the eyelids. Its characteristics are the **yellow colour** due to a granular pigment contained in the connective-tissue cells, its association with chronic jaundice, and its sometimes affecting succeeding generations.

When occurring at its usual site, xanthoma is merely a raised yellow patch which may spread by joining with others. When a definite tumour it usually occurs in other parts of the body.

Chondroma.—A tumour composed of cartilage, and surrounded by a capsule, from which small vascular shoots pass in between the nodules of cartilage. In consistency the tumour varies between fluctuation and dense hardness, the former due to myxomatous degeneration, the latter to ossification ; the greater part of the mass is of a firm, elastic

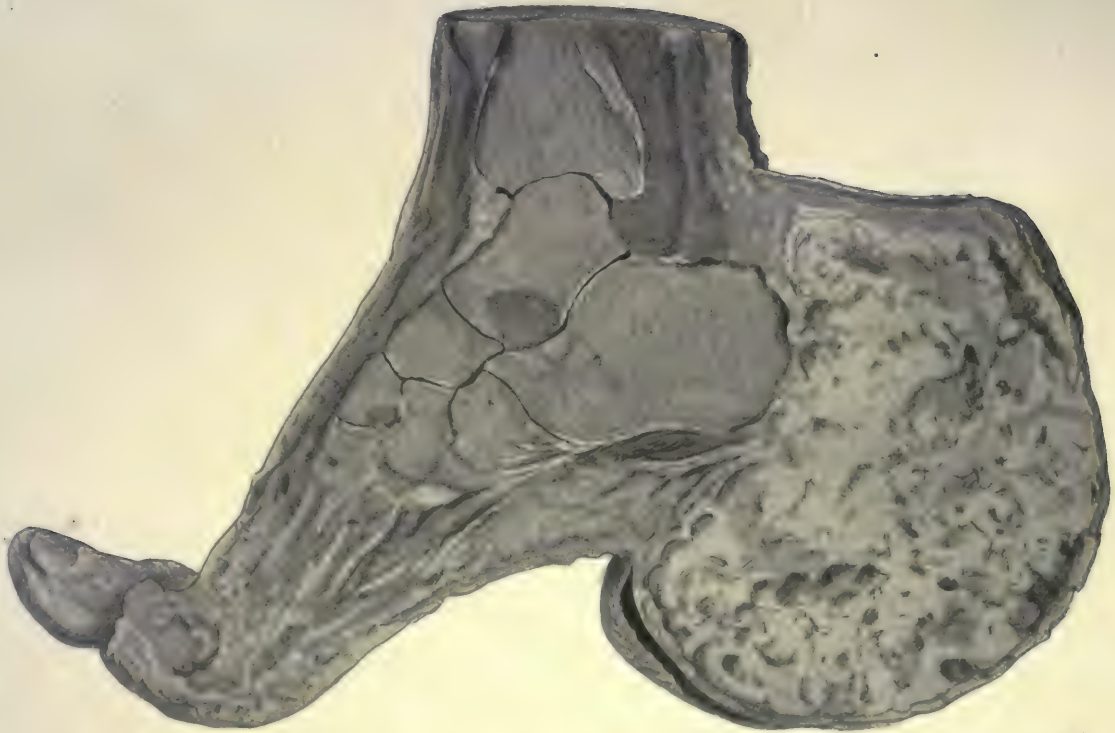
Anatomical Division.	Name.	Structure.	Type.	Character.
Connective-tissue tumours derived from mesoblastic tissue	Lipoma	Fatty	Fully developed	Innocent
	Xanthoma	Connective tissue (yellow pigment)	,,	,,
	Chondroma	Cartilaginous	,,	,,
	Osteoma	Bony	,,	,,
	Odontoma	Dental	,,	,,
	Myoma	Muscular (unstriped)	,,	,,
	Rhabdomyoma	Muscular (striped)	,,	,,
	Fibroma	Fibrous	,,	,,
	Glioma	Neuroglia	,,	,,
	Neuroma	Mixed	,,	Malignant
	Angioma	Vascular	,,	Innocent
	Lymphadenoma	Lymphatic glands	,,	,,
	Lymphangioma	Lymphatic vessels	,,	,,
	Myxoma*	Cells and intercellular mucoid substance	Embryonic	,,
	Myeloma	Giant cells surrounded by round or spindle cells	,,	,,
	Sarcoma	Predominance of cells over intercellular substance	,,	Malignant
Epithelial tumours derived from epiblastic or hypoblastic structures	Papilloma	Central vascular fibrous tissue covered by epithelium	Fully developed	Innocent
	Adenoma	Glandular, or glandular and fibrous	,,	,,
	Carcinoma (cancer)	Fibro-cellular stroma with masses of epithelial cells	,,	Malignant

character. The tumour is a slow-growing one, and, for the most part, painless. It sometimes takes on a malignant character, when it is known as a " chondro-sarcoma."

Situation.—The perfectly innocent variety usually grows from the surface or in the interior of bone ; when in the latter position, it causes a spindle-shaped enlargement, which has to be distinguished from tuberculous and syphilitic disease. Chondromata occur as multiple tumours on the fingers and in the end of the long bones in young people, in which case they have relation to the epiphyseal cartilage ; and it has been suggested that they spring from unused cartilage left behind in

* **Myxomatous degeneration** is a term used when part of a tumour of another structure takes on that of myxoma.

PLATE XVIII.



CHONDROMA OF FOOT, ORIGINATING IN OS CALCIS.

(Museum, Queen's University of Belfast.)

[To face page 126.

the process of ossification. They become ossified usually at the same time as the cartilage from which they spring, when they are called **cartilaginous exostosis.** Rickets would seem to be a predisposing cause in these cases.

Treatment.—Removal with its capsule when growing in the interior of bone. A portion of the surface should be removed, and the tumour cleanly scraped out. When occurring in the hand, amputation may have to be resorted to.

Osteoma.—A tumour springing from bone, and consisting of cancellous or compact tissue. The former structure is chiefly met with at the ends of the long bones, and is a chondroma which has undergone ossification. "Exostosis" is the name often given to this variety, as it projects from the surface; the latter structure is associated with the skull-bones, and may grow inwards, encroaching on the frontal sinus, orbit, nose, or auditory meatus.

Treatment.—Removal should only be undertaken when pressure symptoms occur or grave inconvenience is caused.

Odontoma.—A tumour composed of dental structures in varying proportions and degrees of development. It may arise from the tooth germ or the growing tooth. The tumour is usually not observed till the **eruption** stage, which occurs between twenty and twenty-five years of age, and is usually accompanied by suppuration.

According to the portion of the germ taking part in the growth, odontomata may be divided into—

1. **Epithelial.**—From epithelium of enamel organ, they form multilocular cysts of the lower jaw. They may be malignant.
2. **Follicular (Dentigerous Cyst).**—The distension of a tooth follicle containing viscid fluid; a tooth crown is frequently found in the wall.
3. **Fibrous.**—An overgrowth of the fibrous tissue which surrounds the tooth sac. It prevents the proper eruption of the tooth.
4. **Composite.**—There also occurs a tumour consisting of all the elements of a tooth-germ—enamel, dentine, and cement—which have taken on abnormal growth. It is sometimes found in the position of the permanent tooth, which it replaces; at others, in the antrum or nasal cavity—the latter are sometimes mistaken for osteomata. On section, the tumour is seen to be laminated (Bland-Sutton).

Diagnosis is not very easy, as when suppuration takes place disease of the jaw is closely simulated, while the fibrous variety resembles sarcomata.

Treatment.—When the tumour is solid, it can be removed by dividing the superjacent soft tissue and shelling it out. When follicular, a part of the cyst wall should be removed and its contents scraped out.

Fibroma.—A fibrous tumour, which may be hard or soft according to the proportion of fibres to cells and bloodvessels; the more of the former, the harder the tumour. On section, the hard variety is seen to be dry and glistening, the soft to be moist and pink. The latter grows more quickly, is liable to bleed, and emerges into the sarcomata. Care should therefore be taken to remove the capsule with the tumour.

It is met with in the skin, either as a single or multiple growth, and in subcutaneous tissue; the sheaths of nerves; the gums (epulis); the ovary and uterus.

Special Forms.—*Keloid :* An overgrowth of scar tissue. *Molluscum Fibrosum :* Multiple soft formations of the skin which depends upon a neuro-fibromatosis of the cutaneous nerves (see Neuromata). *Fibromatosis*, formerly known as *multiple neuromata :* An overgrowth of endoneural and connective tissue (see Neuromata).

Treatment.—When causing inconvenience or when malignancy may be suspected, remove.

Myoma.—An encapsulated, vascular tumour, composed of non-striped muscle and connective tissue. The tumour is hard according to the proportion of fibrous tissue present. On section, it has the appearance of fasciculation.

It is met with in the uterus (fibro-myomata), prostate, bladder, and digestive tract.

Symptoms.—There may be none, or pressure may be exerted on uterus, intestine, etc., and profuse hæmorrhage from the uterus may occur. The presence of a fibro-myoma of the uterus will complicate both pregnancy and labour.

Treatment.—Removal, especially when present in the uterus or causing pressure symptoms.

Rhabdomyoma.—A rare tumour composed of striped muscle originating from sequestrated residue. It is met with in the kidney, testicle, and uterus.

Glioma.—A malignant tumour met with in the brain and spinal cord, retina, and optic nerve. It is composed of branching neuroglial cells, grows slowly, and is ill-defined. It is liable to give rise to hæmorrhage and symptoms of pressure on adjacent nerve centres and tracts. Formerly described as a sarcoma, and is often of the nature of a glio-sarcoma.

Neuromata.—It will save confusion to describe here all tumours connected with nerves. They may be **true** or **false.**

The former—*i.e.*, those composed of newly formed nerve tissue—are very painful, and when met with they are almost invariably associated with the sympathetic system.

The false are connective-tissue overgrowths of the nerve, which may result in the formation of a circumscribed tumour or in a diffuse fibromatosis ; the false neuromata are thus divided into—

1. **Solitary Pseudo-Neuroma,** which may be innocent, when it is a fibroma or myxoma ; or malignant, when it is usually a sarcoma.

The growth may spring from the side of the nerve or be central, with the fibres of the nerve spread over it. When situated subcutaneously and on small unnamed twigs, the condition is very painful, and is called a **painful subcutaneous nodule** ; the **trunk neuromata** are much less sensitive. Women are more frequently affected than men.

Treatment.—If painful, the innocent varieties should be removed either without dividing the nerve, or, when this is not possible, by removing a portion of the nerve and suturing the ends. When the sarcomatous variety is present, the limb should be amputated well above the site of the tumour.

2. **Diffuse or Generalized Neuro-Fibromatosis (Von Recklinghausen's Disease).**—Under this head we now rightly describe certain overgrowths related to the nerves, and the condition formerly referred to as **multiple neuromata.**

There is diffused equal thickening of the nerve sheaths, while here and there in the course of the nerves there is a tumour-like swelling simulating the solitary neuroma. These swellings vary in size and number, and are enclosed in a capsule of the nerve sheath.

The cause of the condition is an overgrowth of the endoneural connective tissue, but the nerve fibres undergo no structural change. The distribution of the disease may be over any part of the cerebro-spinal and sympathetic nervous systems.

The history of the disease is somewhat as follows :

If congenital in origin, it usually remains dormant till early adult life, when it is recognized by the occurrence of multiple tumours in the course of the nerves, and at times by the enlargement of superficial nerve trunks. The swellings are as a rule insensitive ; when injured, one or more may become enlarged and sensitive. Unless when the tumour is within the spinal canal, motor disturbances are rare. Brown spots are often observed on different parts of the trunk. The disease may be progressive or more usually chronic ; if the former, the patient becomes exhausted, but, strangely enough, it is often pulmonary tuberculosis that causes death. It is difficult to say whether there is any hereditary element in the disease, but it is frequently seen in members of the same family. A malignant element is introduced as a result of injury, and a tumour takes on the character of a rapidly growing sarcoma, which is characterized by great pain, destruction of the nerve-fibres, followed by paralysis. To be at all effective, treatment of a secondary malignant neuroma must be amputation well above its site.

Treatment.—Little can be done beyond relieving the symptoms and treating complications.

3. What is called **Plexiform Neuroma** may occur during the course of the above disease as a distinct entity. It affects the distribution of one or more neighbouring nerves, often the superficial cervical, or trigeminal, and is frequently associated with a hairy mole. It is characterized by a soft swelling made up of a number of thickened, tortuous strands or cords bound together by loose connective tissue. The mass can usually be dissected out, and the result is good.

4. **Cutaneous Neuro-Fibroma (Molluscum Fibrosum).**—This disease, formerly referred to under the heading of Fibromata, is, as shown by Recklinghausen, a soft fibroma related to the terminal filaments of the cutaneous nerves.

It occurs scattered over the whole body, **except the palms of the hands and soles of the feet,** as multiple soft tumours of variable size, involving the skin, and usually accompanied by tumours of the nerve trunks and pigmentation of the skin. The larger growths should be removed.

5. **Elephantiasis Neuromatosis.**—A condition in which there is extension of neuro-fibromatosis to the skin and cellular tissue of the limb. In its results it resembles elephantiasis, but begins earlier, from ascertainable cause, and is at times associated with multiple tumours along the nerve-trunks. The limb has often to be amputated on account of its weight.

Angiomata.—These are tumours composed of bloodvessels—capillaries, veins, or arteries.

Capillary Angioma (Simple Nævus) —Is composed of dilated capillaries. It is of congenital origin, and may be cutaneous or subcutaneous,

the latter sometimes also involving the skin. When superficial, it is referred to as **port-wine stain** or **mother's mark,** and varies in colour from purple to red. It occurs as a slightly raised mass, very often on the face or other part of the head.

When the tumour is entirely subcutaneous, which is very rare, it forms a round and lobulated swelling, usually of small size and covered by normal skin. It can generally be distinguished by the fact that when compressed it diminishes in size, and gradually enlarges again when the pressure is removed ; but when situated over the usual position of a hernia or meningocele, the diagnosis is not easy, and it may require an exploring needle to settle the matter.

Treatment is not always called for, and the nævus may disappear spontaneously. When required for appearance' sake, or to avoid danger or inconvenience, it consists of—

Excision.

Multiple puncture by means of Pacquelin's thermo-cautery, with the object of causing each puncture to be the starting-point of cicatrization.

Electrolysis to act by cauterization.

Escharotics for small nævi.

Carbon dioxide snow applied as a solid stick for from twenty to forty seconds. This gives good results in the treatment of both capillary and other nævi when they are not too deep (for preparation of solid CO_2 stick, see under Rodent Ulcer, p. 141).

Venous Angioma (Cavernous Nævus).—Consists of a series of blood-spaces. It is usually subcutaneous, but may also involve the skin or be met with in internal organs. The tumour may appear at any age up to middle life, and is of slow growth. It is rounded in outline, is compressible, but quickly fills again when the pressure is removed. There is no pulsation or bruit.

Treatment consists in dissecting out the mass when practicable ; occasionally a spontaneous cure results from inflammation and thrombosis.

Arterial Angioma (Cirsoid Aneurism).—This is composed of the enlarged branches of a main artery ; the condition usually begins in a branch, and spreads to the trunk. The exciting cause is often an injury, though the condition is probably congenital as to its origin. It appears about the period of adolescence, and is usually met with in the head. The affected vessels become tortuous, with alternate narrowing and widening intervals. A loud bruit is always present, and is a distressing symptom.

The **Treatment** is by electrolysis or excision. When the latter is adopted, great care must be taken to control hæmorrhage by means of an elastic tourniquet.

Mixed Angioma, or **Aneurism by Anastomosis,** is one in which all forms of bloodvessels are present. It grows slowly, is met with chiefly in the neck, head, and upper part of the trunk. A bruit is heard over it.

Treatment consists in ligation of the different vessels or in excision.

Nævo-Lipoma is the name given to a tumour rarely met with, which is a mixture of fat and bloodvessels. It is congenital in origin, and

gives rise to a doughy swelling which is a little denser than a pure fatty tumour. There is no thrill, and it is very slightly compressible.

Treatment.—Excision.

Lymphadenoma (Hodgkin's Disease).—An uncommon condition met with in youth, and characterized by enlargement of the glands of a particular group, usually the cervical. They tend to increase in size, but at no time is there pain, suppuration, or involvement of other structures surrounding the glands, which remain separate and can easily be shelled out, thus showing a great contrast to tubercular disease, but in the early stages the diagnosis is not easy. The disease may spread to all the glands in the cervical and axillary regions, and then to the groin through the mediastinal, bronchial, retroperitoneal, and mesenteric chains. The disease may be **acute,** in which case there is rapid dissemination, causing death in eighteen months ; or **chronic,** in which the disease is confined to the cervical glands for years. The cause is unknown.

The **Treatment** is unsatisfactory ; it consists of arsenic internally and by hypodermic injection, and excision when the tumour causes danger or inconvenience from pressure.

Lymphangioma.—A tumour formed by the dilatation of lymphatic vessels, or a new formation of such vessels and spaces filled with lymph. It is of congenital origin, appearing shortly after birth.

Two varieties are described—

1. The **Cavernous,** which is formed of alternating spaces and channels. It exists as a soft swelling not unlike a subcutaneous nævus, but, unlike it, the tumour cannot be emptied by pressure, and puncture reveals the presence of lymph, which also distinguishes it from a lipoma.

Situation.—Skin, mucous membrane, especially of tongue, and lower lip.

Treatment.—Excision or electrolysis.

2. The **Cystic** (lymphatic cyst ; cystic hygroma), formed by one or more cysts which have resulted from the cavernous variety, in all probability by the breaking down of septa, so that, as might be expected, there are forms which partake of the character of both varieties. The condition is commonly met with beneath the deep fascia of the neck, projecting at the side of the sterno-mastoid, in the axilla, and groin. They are recognized by the history, situation, and contents. They may shrink, suppurate, or remain stationary.

Treatment.—Injection of iodine. Excision is not to be recommended owing to the deep dissection required.

EMBRYONIC CONNECTIVE-TISSUE TUMOURS.

A. Innocent.

Myxoma.—A tumour consisting of connective-tissue cells and mucoid intercellular material. It is very rare to meet with a growth composed entirely of this material, but the condition is frequently met with as a result of degeneration in other connective-tissue tumours.

Myeloma.—This tumour used to be called a **myeloid sarcoma,** but it is not malignant. It is usually met with at the ends of long bones,

and consists of giant cells (multinuclear), with a number of round and spindle cells surrounding them.

The tumour should be removed, together with any surrounding diseased material.

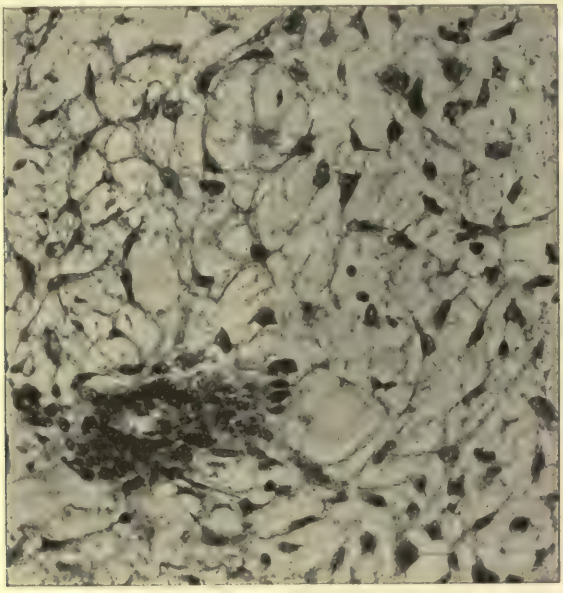


FIG. 21.—MYXOMA OF THE BREAST.
(Beattie and Dickson.)

B. Malignant.

Sarcomata.—Those connective-tissue tumours which exhibit the characteristics of malignant growth. In structure they show a preponderance of cellular elements over stroma, thus approximating to embryonic connective tissue. The sarcomata may spring from any connective tissue, but are found most frequently in the skin, fascia, or intermuscular tissue, periosteum, or bone marrow.

In structure sarcomata are rounded tumours, with a capsule composed of the compressed surrounding tissues; they are very vascular, the blood being contained in spaces rather than in vessels; hence they bleed easily and profusely, and transmission occurs through the bloodstream, and rarely by the lymphatics, unless the primary disease is in lymphatic tissue.

A good deal of confusion is caused in the mind of the student by the numerous names given to the sarcomata, because of some outstanding feature of the tumour—as **angio-sarcoma,** so called because of the presence of an unusually large number of bloodvessels in the structure of the tumour. Let it be clearly understood that, as already stated, **sarcomata are those embryonic connective-tissue tumours which show malignant characteristics,** and remembered that the varied nomenclature simply arises from the size or variety of the cells, from degeneration, or from some part of the growth having the character-

istics of another structure which gives its name to the compound title, as **osteo-sarcoma**, in the case of a sarcoma in which part of the tumour has become ossified.

The smaller the cells, the more malignant is the tumour as a rule.

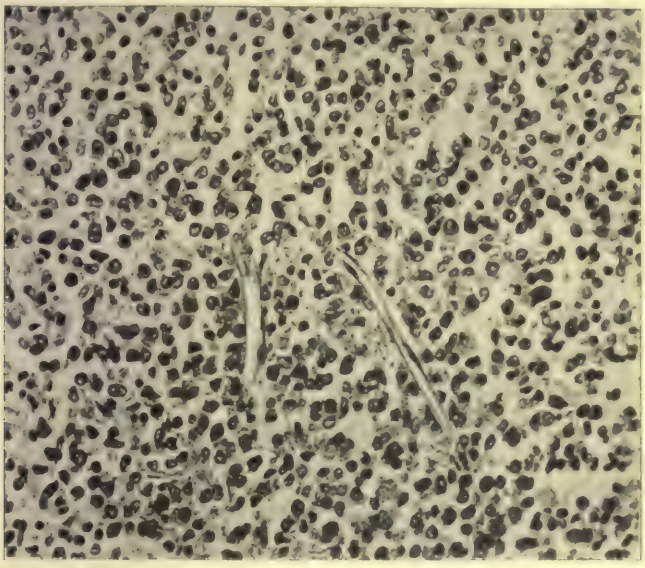


FIG. 22.—SMALL ROUND-CELLED SARCOMA.
(Beattie and Dickson.)

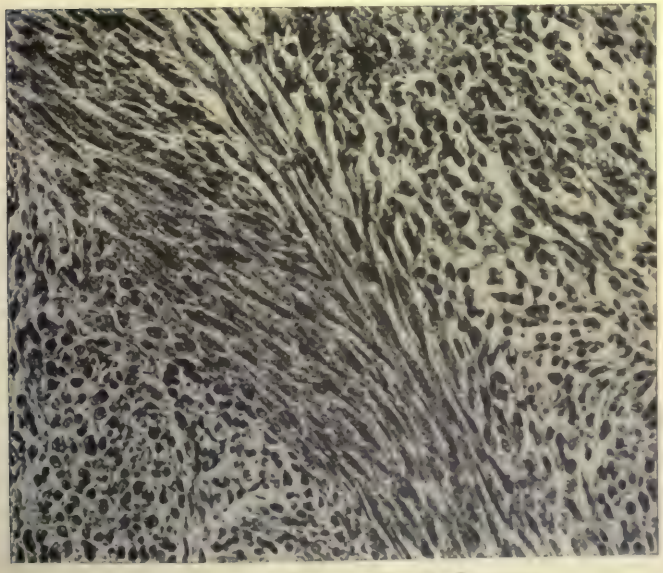


FIG. 23.—SMALL SPINDLE-CELLED SARCOMA.
(Beattie and Dickson.)

The following table gives the varieties :

Name.	Structural Variety and Distribution of Tumour.
Small round-celled	Round cells with very little intercellular substance. Universal distribution.
Large round-celled	Larger cells with a more marked stroma.
Lympho-sarcoma ..	Small round cells with fine intercellular network resembling a lymph-gland.
Small spindle-celled	Small, oat-shaped cells, sometimes green (chloroma), with a fair amount of intercellular tissue, which may be abundant and develop in fibrous tissue (fibro-sarcoma ; recurrent fibroid of Paget). Grow from periosteum, ovary, testis, mamma, kidney, parotid.
Large spindle-celled	Softer and of a deeper colour than above.
Alveolar	Cells arranged in alveoli resembling carcinoma. Grow from skin and hairy moles.
Melanotic	Cells various, often arranged as above, contain brown pigment. Grow from skin, nails, vulva, anus, palate, uveal tract.
Endothelioma ..	Lymphangio-sarcoma. Cells derived from endothelium of lymphatic spaces and vessels, or from bloodvessels. The cells are arranged in columns, which give a likeness histologically to **epithelioma.** The growths are met with in glands such as the parotid and testis, on the palate, and in connection with serous membranes. Great variety of type is shown, and a tendency to transformation and degeneration. It is slightly malignant, and may return locally. Lymphangio-sarcoma and endothelioma are sometimes described separately—the former being regarded as malignant, the latter as innocent. There seems no good reason for distinction. Lazarus Barlow gives lymphangio- and hæmangio-sarcomata (the latter a very rare tumour from the endothelium in and around the small bloodvessels) as divisions of the endotheliomata. The name **psammoma** is given to an endothelioma springing from the cells covering the choroid plexus of the brain ; it contains a material resembling sand.
Hypernephroma ..	(*Adrenal tumour.*) Resembles the structure of the adrenal *zona fasciculata.* Occurs in adrenal or in accessory adrenal glands.
Glio-sarcoma Myxo-sarcoma Chondro-sarcoma Myo-sarcoma	Develop in existing innocent tumours of the nature indicated by first part of name.
Osteo-sarcoma ..	Formation of true bone in tumour by ossification. "The medullary spaces are filled with sarcomatous cells instead of marrow." Other varieties are the **osteoid sarcoma,** in which there are no lime-salts and **petrifying sarcoma,** which is characterized by having calcified areas in the stroma. Met with in bone, muscular tissue, the mamma, and in other situations.

The sarcomata in their growth often cause pressure on and destruction of neighbouring structures. Pyogenic infection may take place during the course of the disease. The skin may become involved, either by the disease attacking it or by sloughing owing to pressure. Small portions of the growth extend into the veins, and, becoming detached, are carried to some other situations, and being there intercepted by the capillaries, form secondary deposits. If large enough, the portion detached may add the danger of embolism.

Signs and Symptoms.—These will vary with the situation.

PLATE XIX.

MELANOTIC SARCOMA.

The starting-point of the growth was a pigmented mole.

(Museum, Queen's University of Belfast.)

[To face page 134.

No *absolutely* definite condition exists in the early stage to stamp this tumour as something apart from an innocent growth, a cancer, or an inflammatory swelling. There is usually pain, though probably not at the onset, which may be slight or very severe. This is caused by tension, so, in such a growth as the quick-growing endosteal variety it is marked. If the pain suddenly increase and there is an accompanying increase in the size of the tumour, hæmorrhage has probably taken place into a sarcomatous growth. Cystic sarcoma is indicated by a number of soft spots over the growth.

Diagnosis.—While the diagnosis, like the symptoms, will vary with the position, it may be broadly stated that sarcomatous conditions differ—(*a*) from inflammatory (tubercle or syphilis) in history, absence in the early stages of local pain, redness, and tenderness, more rapid growth, absence of Altmann's granules ; (*b*) from innocent tumours in more rapid growth and physical characteristics ; (*c*) from cancers in more rapid growth, greater blood-changes, non-involvement of lymphatic glands. The differences between sarcomata and carcinomata may be tabulated as follows to form a rough guide :

	Sarcomata.	Carcinomata.
Growth ..	Rapid	Not so rapid
Extension ..	By blood-stream	By lymphatics
Capsule ..	False capsule present	No capsule
Structure ..	Cells not in alveoli, except in alveolar variety	Cells arranged in branching alveoli
Malignancy ..	Varies, in some cases only local return	Malignancy on the whole greater

Treatment.—Complete removal, including an area of apparently healthy tissue and the skin if suspected, carried out at an early date before there is any dissemination, gives good results, except in melanotic sarcoma and sarcoma of the femur, where they are not good.

X-ray treatment has been found useful in certain cases where complete removal is impracticable, either alone or after partial removal of the tumour.

The treatment of malignant disease by radium will be referred to under Treatment of Cancer.

Injection of **Coley's fluid,** which is a mixture of the **toxins of the streptococcus of erysipelas, and B. prodigiosus,** is useful in some sarcomatous tumours, especially the **spindle-celled varieties,** which are inoperable. In this treatment small doses—$\frac{1}{4}$ minim diluted with $\frac{1}{4}$ drachm of boiled water—are used to begin with ; these are increased till a smart reaction is caused, with a rise of temperature of from 102° to 105° F. The doses are repeated daily for at least four weeks if there be no improvement, evidenced by the shrinkage of the tumour and by its becoming more movable and less vascular. If improving, the treatment should be kept up for a year. If very vascular, the injection should be made near, but not into, the tumour. When increasing the dose, an additional $\frac{1}{4}$ minim is sufficient when the tumour itself is injected, but $\frac{1}{2}$ a minim may be added otherwise.

The reason this treatment was devised was because of the good effect an attack of erysipelas was observed to have on a sarcomatous tumour.

The treatment has also been adopted by Coley to prevent recurrence after operations.

EPITHELIAL TUMOURS.

A. Innocent.

Papilloma.—Springs from cutaneous or mucous surfaces, and consists of a central axis of vascular fibrous tissue surrounded by a layer of epithelium which resembles that of the surface from which they grow. **The epithelium never dips down into the tissue below the basement membrane.**

The varieties are—

Warts occurring on skin, tongue, and larynx, covered by epidermis or epithelium.

Villous.—The surface epithelium projects as a filiform process. Occurs in bladder chiefly, also in the kidney (renal pelvis) and choroid plexus of the brain.

Intracystic.—Met with in cysts of ovary and breast, and in the ducts of the same glands.

The papillomata are innocent tumours, but continued irritation may produce malignancy; it is therefore wise to remove them. This is usually a comparatively simple procedure.

Adenoma.—An innocent tumour consisting largely of gland tissues, often encapsulated, unconnected with ducts. Where it projects from the surface of the mucous membrane, the tumour is often termed a "polyp."

Varieties—*Fibro-Adenoma.*—Formed of an admixture of gland and fibrous tissue. Met with in the uterus.

Myxo-Adenoma.—So called when the tumour contains myxomatous tissue.

Cystic Adenoma.—When gland spaces of the tumour become distended with secretion. Met with in ovary and mamma.

Intracystic.—When the tumour tissue projects into the interior of the cysts.

This tumour may occur in any gland, but is most common in the mamma, ovary, parotid, thyroid, sebaceous glands, and uterus.

Treatment.—The tumour should be removed as a rule.

B. Malignant.

Carcinoma (Cancer).—As the sarcomata are the malignant members of the connective-tissue group of tumours, so the carcinomata are the malignant members of the epithelial group.

The essential constituent of a cancer are cells derived from proliferation of existing epithelium which invade the connective tissue in simple or branching columns. These columns are enclosed in alveoli, which are simply dilated lymphatic spaces **communicating fully with lymphatic vessels.** Hence their method of spreading and the outstanding divergence from sarcomata, and hence the difficulty of treatment, since the disease has to be dealt with at a very early stage in order to find that the neighbouring lymphatic glands are not enlarged. Modern treatment carries out most elaborate operative procedures to endeavour to remove *all* affected glands; but once they are affected, it is a very difficult thing to do, and a return locally or internally is the rule unless the disease is got in its initial stages.

Another difficulty of complete extirpation is the tendency to infiltrate which cancerous growths show, and the want of any definite capsule or even boundary to the growth, so that not only is the whole of an organ affected, but also the neighbouring structures. Secondary growths are most common first in the lymphatic glands, and then in the liver, lungs, serous membrane, and bone marrow.

There is probably a predisposition towards the disease in the tissues attacked which is excited to action when they reach the involution period; this varies for different tissues, cancer of the rectum and stomach being comparatively early, that of the mamma and uterus relatively late. Chronic irritation, such as that caused in the tongue by constant use of a short clay pipe; and in the skin of workers in tar, paraffin, soot, etc., or by X rays, may be the exciting agent.

The disease may begin as a papillary growth from mucous membrane or skin, as a nodule in solid organs, or as a thickening more or less diffuse in others, as the stomach or intestine, where a central space exists.

Necrosis of the tumour may take place, and an ulcer may form when the skin or mucous membrane gives way.

Malignant Ulcer has the following characteristics—*Edges:* Irregular, indurated, and raised. **Special feature: Show growth in excess of destruction.** *Base:* Smooth and glazed, or covered with slough. *Discharge:* Blood-stained and offensive. *Surrounding Part:* Unhealthy.

Contagiousness.—Cancer is not contagious from one human being to another, but adjacent parts in the same individual may be affected, as from one lip or one labium majus to the other; so an operation wound may cause infection elsewhere by the liberation of cancer cells from the main growth. In the lower animals of the same species cancer may be grafted from one to the other.

Signs and Symptoms.—The cancer tumour is hard, with a nodular surface, no well-defined edge, adherent to the tissues, and tending to invade them and the neighbouring glands.

The patient usually says that no tumour existed till a very short period before examination. The real meaning of this is that it was not observed previously, and some small accident often first attracts the patient's attention, and the condition is attributed to that occurrence. The reason for this non-observance is that there is **no pain** in the early stage, nor is there any alarming symptom of any kind, and it is to this that, no doubt, may be attributed the fact that in this most hopeful, early, painless period patients very rarely come for advice, or, having come, submit to, operation.

Of the symptoms which point to the possibility of a cancer we may mention—**hæmorrhage** from internal organs; **chronic ulcerations**, especially of tongue, not amenable to antisyphilitic treatment. **Stricture** of a hollow viscus, presence of a **tumour** not unquestionably innocent, the development of **cachexia,** by which is understood a condition of general ill-health and wasting, produced by the absorption of toxins from the cancerous growth; this is present in most forms of cancer, and may of itself cause death by progressive loss of strength.

The **Prognosis** in cancer differs with the age of the patient and the situation of the growth. Atrophic cancer of the breast in old people and some forms of cancer of the rectum are very slow in their growth, and do not materially shorten life or interfere with health; at the other extreme are soft tumours of the breast in young, strong women.

" The harder and more defined the growth, the better the prognosis. The more closely cancer resembles an inflammatory swelling, the worse the prognosis ; the more localized the tumour, the better it is. . . . Fibrosis is the cause of hardness, and fibrosis is an attempt at natural cure " (Rutherford Morison).

Cancer of the œsophagus will kill soon owing to inability to swallow, and, if the larynx or throat, from inability to breathe. In the digestive tract, obstruction is to be feared ; in the genito-urinary, hæmorrhage.

Treatment.—Complete removal by the knife still holds precedence over every other method so long as the tumour is dealt with at an early stage. By complete removal is meant the taking away of the tumour, together with a circumference of **apparently** healthy tissue, or of the organ in which the tumour is situated ; as well, the nearest set of lymphatic glands and the vessels which feed them from the tumour should be removed where at all possible, since these glands and lymphatics often contain cancer cells, even though they have not yet become obviously affected with the disease. Provided such an operation is carried out while yet the tumour is in its early stage, and when little or no enlargement of glands or interference with general health has occurred, complete cure of the disease is the rule, not the exception.

In favourable cases about 60 per cent. have no return of the disease.

Palliative Treatment.—(*a*) *Radium.* The treatment of sarcoma and carcinoma by radium is confined, in the present state of our knowledge, to those cases which are considered inoperable or in which a partial operation of a palliative nature has been carried out. It is, however, probable that in the future radium will be used as a first treatment in many cases of malignant disease. Lazarus-Barlow has recently pointed out that the radiations of radium in infinitesimal doses are a possible cause of new growth, owing to the stimulation to cell growth which they may occasion. It also " cures," if administered in sufficient strength, by its capacity of killing every type of cell met with in cancer. The action of radium is selective, and therefore has a different effect on different cells. Thus radium has much greater effects on rodent ulcer and round-celled sarcoma than on squamous or spheroidal-celled sarcoma, while on columnar-celled carcinoma it appears to have little effect. This is probably due to the fact that at present all varieties are treated with practically the same dose and for the same period. When we have more control over the action of radium, the results of its use will be all the better on account of its selective action, as in this way it will be superior to the knife. After a complete operation radium should not be employed, as its action will be to further interfere with the fighting power of normal cells already weakened by operation, and so probably defeat the object in view—namely, the destruction of isolated foci of the disease, which the normal cells might have dealt with. As Lazarus-Barlow points out, if radium is to be used subsequently to a partial operation, then a certain amount of cancer tissue should be left behind. Otherwise the radiations in destroying the few remaining cancer cells will also largely destroy the normal tissue, and an autogenous antibody will not be formed, since its formation by radium must depend upon the diameter of the mass of malignant cells through which the rays are able to act, as well as upon the quantity of radium in use.

Radium is chiefly employed either in the form of a salt or in the gaseous form of " radium emanation." In both cases the substance is enclosed within some form of applicator, which differs in shape,

nature, and thickness of screen, etc., according as it is desired to treat a mass superficially, or to bury the radium in its centre. It is necessary to point out that radium "burns" analogous to X-ray "burns" are produced with great ease, so that the treatment is not devoid of considerable risk in inexperienced hands.

(*b*) *X Rays.* Useful, especially in skin cancers. The treatment is curative in some cases, especially that form known as "rodent ulcer," which is very feebly malignant. The use of X rays following operation is often beneficial, and also to improve the condition in inoperable cases.

(*c*) *Fulguration.* This treatment is carried out by means of currents of high frequency and tension. The mode is best adopted in conjunction with some minor operative procedure, as curetting, whereby much of the growth may be got rid of.

(*d*) *Starvation of the Growth* by ligature of the feeding arteries is sometimes of considerable benefit.

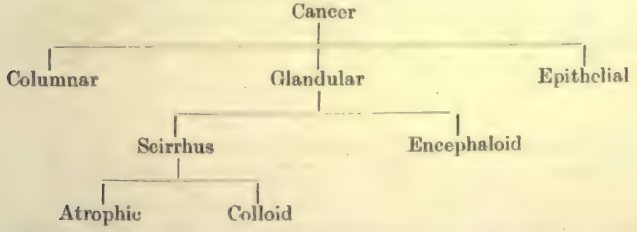
(*e*) *Hygienic Treatment.* Rutherford Morison points out that much may be hoped for "from systematic treatment of inoperable cancer, on the same lines as that which has proved so successful in tuberculosis," and that such treatment should certainly be carried out in cases which have been operated on.

(*f*) *Certain Operations* are undertaken, for the relief of symptoms, which do not aim at the removal of the growth, such as tracheotomy, gastrostomy, gastro-enterostomy, for relief of laryngeal, œsophageal, and intestinal obstruction respectively; and the local removal of the tumour to prevent or cure sepsis.

(*g*) *Narcotics.* When the case is quite hopeless, and especially where there is great pain, narcotics should be freely given, and their constipating effect counteracted by purgatives.

Varieties of Cancer.

Carcinomata are divided under separate headings, according to their character or the arrangement of their cells, and there exist certain subdivisions. These will perhaps be best remembered by the student with the help of the accompanying table:



Columnar-Celled Carcinoma (Columnar Epithelioma). — Occurs in mucous membrane covered with columnar epithelium, and is met with usually in the stomach and intestines. It resembles adenoma in structure; hence the name of malignant adenoma sometimes given to it.

Glandular- or Spheroidal-Celled Carcinoma.—Met with in the breast, the glands of mucous membranes, etc. The cells are arranged in columns or closely packed alveoli. Where there is much fibrous tissue between the cells the tumour is called a **scirrhus carcinoma,** a very hard growth common in the breast.

When the intercellular stroma is small in amount and delicate in structure, a soft, very malignant tumour results, called an **encephaloid carcinoma.**

If the intercellular structure is very dense and strong, the cancer cells may undergo atrophy, and the tumour shrink owing to the compression of the nutrient vessels. This is known as an **atrophic scirrhus.**

If degeneration takes place and the spaces become filled with a gelatinous material, **colloid cancer** is produced.

Epithelial Cancer.—Springs from a surface covered by squamous epithelium, as the skin and mucous membrane of the mouth, gullet, larynx, or bladder. The type of this form of cancer is epithelioma.

Skin Cancers.—Epithelioma (squamous epithelial cancer) occurs on surface covered by stratified epithelium. It is common at the junction of skin and mucous membrane, as on lips or at anus, etc., and at the site of old scars, ulcers, etc.

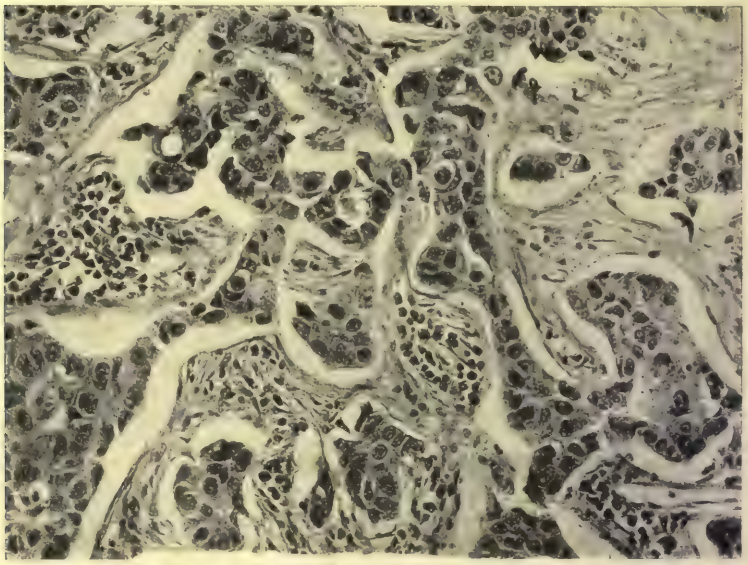


FIG. 24.—SCIRRHUS CARCINOMA OF THE BREAST.
(Beattie and Dickson.)

The characteristic of the tumour is that the columns of epithelial cells retain their original character when they grow downwards, and they are compressed within the lymphatic spaces and undergo a horny change ; these masses of hardened cells are termed **cell nests** or **epithelial pearls.** Clinically, the disease is characterized by a very early, constant extension to the lymphatic glands ; but for this, treatment would be much more satisfactory, since the tumour itself is a slow-growing one.

Rodent Ulcer.—A form of ulcer which resembles epithelioma in that the cells are epithelial ones arranged in columns, but differs in that (*a*) the cells are smaller ; (*b*) cell nests are never present ; (*c*) the lymphatics are seldom or never involved ; (*d*) the deep processes spread laterally ; (*e*) there is correspondingly little cell infiltration around the new growth.

The disease is met with on the upper part of the face, especially the inner or outer canthus of the eye, and is usually characteristic in appearance. It springs from the sebaceous glands, and begins as a nodule on the skin. Ulceration takes place after some years, which, if allowed to go on, may destroy all the tissue in its path. The ulcer shows a raised, rounded outer border, and the surface is covered by a scab; but it never heals by cicatrization, and constantly breaks down. There is itching, but no pain.

Lupus has been mistaken for the disease. It, however, begins in earlier life, has apple-jelly nodules, and there exists no rounded outer border.

Treatment.—Excision clear of the diseased margin is probably the best treatment in moderate-sized circumscribed ulcers. There is often no need to cut beyond the skin and fascia, as the disease in the early stages does not spread downwards; the healthy skin may then be stitched together, and no scar remains.

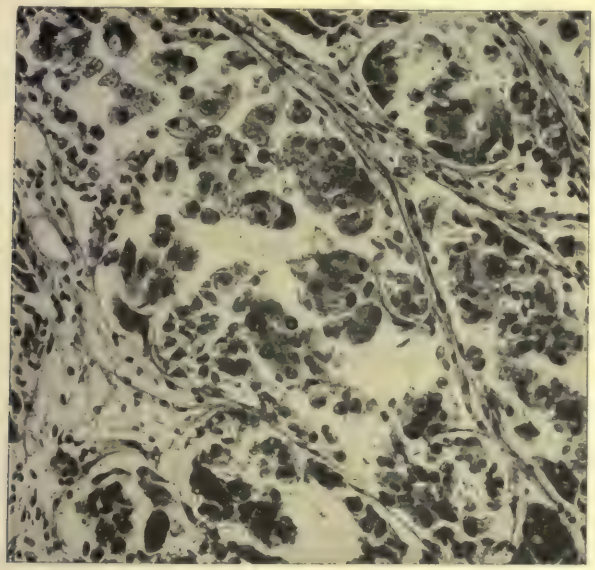


FIG. 25.—ENCEPHALOID CARCINOMA.
(Beattie and Dickson.)

If the ulcer be very large, the use of radium or X rays is the best method of treatment. The application of solid carbon dioxide snow gives excellent results, and, owing to the ease of its application, it has to some extent replaced other methods of treatment.

Application of Carbon Dioxide Snow.—The gas is contained in iron cylinders under pressure, and its sudden expansion reduces the temperature, so that it is condensed into snow at a temperature of 110° below zero (F.). Some one of the special apparatus may be obtained, but it is possible to adapt the treatment by means of the cylinder and a small chamois bag, which is placed over its orifice, and tied by means of a tape passing round the mouth of the bag. The gas is allowed to escape in short puffs or jerks; care is to be taken that too much is not allowed to escape at once, and at the same time enough to form sufficient snow. The cylinder is to be held slantingly downwards, as

is the liquid CO_2, the sudden expansion of which so reduces the temperature as to form snow. The snow is now collected and passed into an ordinary tin funnel with a tube of about ½ inch in diameter; it is hammered down into a stick by means of a glass or wooden rod. When enough has been collected, it is passed out and held with a piece of lint, and applied to the affected part. The skin is to be prepared by careful washing with soap and water, and a little weak antiseptic. The stick is now to be held to the edge of the ulcer for from fifteen to sixty seconds, according to the thickness of the border ; it must be frozen, but not kept on so long as to endanger its vitality ; the border is to be first gone round, and then the base. In small ulcers healing commences in a few days.

Melanotic Cancer.—A new growth of the skin containing melanin. It usually begins in a pigmented mole, often on the sole of the foot ; the disease is rapidly disseminated along the lymphatics ; the vessels themselves may be attacked, showing a remarkable condition of pigmented cords, or the glands may become much enlarged. The tumour and surrounding healthy skin should be removed, together with the nearest group of glands.

Chorion Epithelioma.—A tumour occurring in the uterus after miscarriage.

Dermoids.

Dermoids are tumours of skin or mucous membrane occurring where, normally, such structures do not exist.

Sequestration Dermoids are skin dermoids, so called because they arise from portions of embryonic epiblast **sequestrated** or detached during development. They are situated in the mid-line of the body in the trunk, but more commonly on face and neck, in the position of the embryonic clefts and fissures ; the inner and outer canthus of eye is a favourite situation. They consist of a globular cyst, the wall of which is formed of skin and contains fluid, with hairs, epithelium, fat, and cholesterin crystals.

Tubulo-Dermoid arises in persistent fœtal ducts. They are—*Lingual :* At upper part of thyroglossal duct. *Branchial :* Underneath the deep cervical fascia at the branchial clefts. *Rectal :* Projecting into the rectum, or lying between rectum and sacrum, or bulging posteriorly as a sacro-coccygeal tumour. *Urachal :* In connection with persistence of urachus. All these dermatoids have a wall of mucous membrane, and contain secretion of mucous glands.

Treatment.—Removal by dissection and cicatrization of any portion left behind.

Ovarian Dermoid.—A fairly common tumour of the ovary. (See Genito-Urinary Diseases of Women, Chapter XXXII.)

Teratoma.—Differs from a dermoid in the embryonic character of the tissues, by its greater rapidity of growth, and by containing structures derived from all the layers of the embryo. The tumour probably represents a second badly developed ovary, forming a parasitic fœtus or compound twin. They are met with as tumours growing as a rule from the back of the sacrum. Their removal will depend on the individual conditions of the case.

A similar tumour may occur in testicle and ovary.

Cysts.

These usually appear as round swellings composed of fibrous tissue with a lining of epithelium, and containing fluid or semifluid material.

Varieties—*Implantation Cyst.*—As the result of an accident, a piece of skin is driven into the tissues, where it forms a small cyst. Remove by dissection.

Retention Cyst.—Develops when the duct of a secreting gland is partly obstructed. Met with in breast, pancreas, glands.

Exudation Cyst.—Results from distension of cavities with no ducts, as in the thyroid.

Parasitic Cysts.—These are due to a parasite which forms a cyst in some tissues of the body. The best known is the **Tænia echinococcus,** which occasions the **hydatid cyst,** usually in the liver.

Hydatid Cyst.—Is rare except where the dog lives with human beings, as in Australia and the Arctic regions. The parasitic *Tænia echinococcus* is a small tapeworm which inhabits the intestines of dogs in the adult stage. It is ½ inch in length, having four segments ; the head has four suckers and a row of hooklets ; the posterior segment contains the genital organs. The ova is discharged from these, and through contaminated food or water enters the human host to develop in the stomach or intestine as an embryo with four suckers and a set of hooklets. It burrows through into the blood-stream, and is conveyed to the liver as a rule, or to some other tissue. Wherever it is deposited, it forms a cyst which consists of two layers—an ectocyst, or external firm layer, and an endocyst, or internal granular layer—the whole being surrounded by a fibrous capsule derived from the tissues of the host. From the endocyst grow daughter cysts, blood-cysts with embryos in their interior, and heads of mature worms called "scolices." The cysts contain fluid, with numerous free hooklets, by which it is recognized. Sometimes the cyst contains no scolices and daughter cysts, when it is known as a "barren" or "acephalo" cyst ; while, on the other hand, there may be no containing cyst, but only daughter cysts and scolices lying free in the tissues. This form is usually met with in bones, and is known as "exogenous development."

Next to the liver, the tissues most frequently attacked are those of the brain, kidney, and bone.

A hydatid cyst may continue to grow till it causes pressure symptoms, or it may rupture into a serous cavity, giving rise to blood-poisoning and multiple growths, and occasionally suppuration takes place within the cyst. Should the parasite die, the cyst shrivels up, and may become calcified.

Treatment.—Excision, or incision, with removal of contents.

Cysticercus Cellulosæ is the embryonic form of the ordinary tapeworm usually formed in the pig at this stage, but occasionally forming cysts in the brain, the eye, or under the skin in man.

Blood-Cysts result from the encapsulation of extravasated blood or by hæmorrhage into a pre-existing cyst. The saccule of a varicose vein is not a true blood-cyst.

Lymph Cysts are formed by the tearing across of lymphatics by contusions which draw the skin from the subjacent tissues. The cyst, which is usually situated beneath the skin and above the fascia, contains serum, clear or blood-stained. When the latter, they were formerly confused with blood-cysts, but, unlike these latter, the contents do not tend to become absorbed. These cysts should be aspirated and pressure applied.

CHAPTER IX

AFFECTIONS OF THE SKIN AND ITS APPENDAGES

Blisters—Callosities—Chilblain—Boil—Carbuncle—Horn-Cysts—Abscess—Acne—Tuberculosis—Molluscum contagiosum—New growths—Affections of the nails

THERE are certain affections of the skin and nails which come within the purview of the surgeon, either in whole or in part, during some period of their course, and are amenable to surgical treatment for their relief or cure.

Many disease processes involve the skin secondarily, or, beginning in the skin, spread rapidly to other structures ; such conditions are not dealt with here, but are treated of elsewhere under the headings of the diseases concerned.

Blisters.—These are large or small collections of serum under the horny layer ; they are caused commonly by intense heat, moist or dry ; intense cold, as by the frozen carbonic acid gas ; friction, as in rowing when the hand is not accustomed to handle the oar ; or in sliding down a rope. A severe nip or crush of the skin between two hard ends often gives rise to a blood blister, where some blood is effused as well as serum. **Therapeutically** a blister is produced by the application of some irritant, chiefly some form of cantharides.

Treatment.—Probably the best treatment is to leave the blister alone and cover it with some soft clean gauze ; a little boracic powder should be sprinkled on the surface. Some prefer to let out the fluid, but what the advantage is in that proceeding has never been demonstrated, except the bulky amount of fluid is inconvenient ; there is no more soft and natural application to the raw Malpighian layer than the natural serum. If it be let out, a small aperture should be made with an aseptic sharp point, and the fluid let drain away into some aseptic wool ; on no account is the epithelial covering to be torn off if it can be avoided. Blisters may sometimes be avoided, as in rowing, by keeping the skin of the palm dry.

Callosities.—This name is applied to greatly thickened patches or areas of epithelium. A callosity occurs where there has been intermittent pressure and friction ; it is commonly a trade-mark, and the occupation of a patient may not infrequently be inferred at sight ; it is often of great help to the amateur Sherlock Holmes.

Treatment.—If the patient continues his or her occupation, little can be done to remove the effect. The part is to be softened by soaking in warm water, or covered with an impermeable material, and then rubbed with pumice-stone or scraped with a knife. Unna's salicylic

acid plaster is a cleanly and convenient method of treatment ; it is to be renewed every second or third day. Painting with soft soap in solution or with weak soda or potash solution will also soften ; occasionally a part may be removed entirely by the knife.

Clavus (*Syn. :* **Corn**).—This differs from a callosity in the fact that it is generally much smaller, is more conical in shape; the apex tends to press in on the delicate nerve endings ; it is also caused by intermittent pressure.

Treatment.—If the patient is skilful enough or has the means to fee his doctor, the corn may be cut out once every month ; the surrounding callosity furnishes a protecting pad, and relief is obtained for the time. A wedge-shaped piece of the corium may be removed, and permanent relief obtained. The following may be applied :

Acid. salicylic.	ʒss.
Tr. cannabis indicæ	ɱxx.
Collodion	ℨss.

This is to be painted on nightly for a week, and the dry epidermis removed ; then the medicament reapplied.

Chilblain (*Syn. :* **Pernio**).—The manifestations of this affection are familiar to most of us ; it is found on the extremities, such as the fingers, toes, ears, and nose. The part is red and swollen, and has generally a burning itch. As regards the pathology, there is a curious and interesting mixture of local exposure to cold, and a special susceptibility or constitutional vasomotor weakness ; there is also a relationship with lupus erythematosus, and a patient suffering from this latter affection has generally, more or less, the chilblain diathesis. Those with the large, reddish, easily swollen hand, turning blue and pink on exposure to cold, are especially liable ; and we see here a connection with Raynaud's disease, especially with the asphyxial form. This vasomotor weakness is not clearly understood ; we must be content to accept it as an ultimate fact.

Treatment.—We cannot change the diathesis, but a patient may slowly grow out of it, or the effects of the irritating cold may lessen. The best method to aid this process is, shortly, to keep oneself in good form ; to exercise the part most liable ; to promote free circulation by avoiding all tight clothing, gloves, and boots. Each attack seems to increase the predisposition, so that the hands are to be washed in warm water, perhaps with a sudden douche of cold, and then well rubbed with a warm dry towel ; light, loose, warm gloves are to be worn, and put on before going out. Innumerable local applications have been recommended. As a matter of experience, there is not one that commands confidence ; the tr. iodid. decolorat. is one of the best known ; 15 grains of the chloride of calcium thrice daily has been advised, but not found better than many other remedies. One lady who was liable to chilblains each winter escaped the three winters in which she was pregnant.

Furunculosis (*Syn. :* **Boil, Furuncle**)—**Definition.**—An acute, circumscribed, phlegmonous inflammation round a skin gland or follicle, resulting in necrosis and suppuration.

Symptoms.—It begins as a painful spot, red, hard, convex, and finally points ; the centre softens, and a small slough is slowly separated,

with great relief to the burning and throbbing pain ; the swelling subsides, granulations fill up the cavity, and a scar is left. Boils may come singly or in crops, or return each season, especially in the spring, for a number of years. It may stop at suppuration, and a "blind boil" be formed. The lymphatic glands are apt to be inflamed. Boils may occur anywhere, but are chiefly found on the face, forearms, neck, buttocks, and legs. They are liable to appear where there has been friction or injury, as in the buttocks of oarsmen. They are apt to complicate diabetes mellitus, any lowering infections—pruritus, eczema, etc.—and to be spread by scratching or by poulticing.

Pathology.—The pathology is an inflammation produced by the invasion of the skin by, chiefly, if not entirely, the *Staphylococcus aureus* through the hair follicles or sweat glands. The small vessels round the spot become blocked, and a necrosis results with more or less suppuration.

Diagnosis.—See Carbuncle.

Prognosis.—This is good in the vast majority of cases ; the affection increases the gravity of depressed vital conditions. One boil generally lasts about fourteen days. If it occur in crops, it is more difficult to prognose the advent of sound health, although with the vaccine treatment one may venture roughly on one to three months.

Treatment.—*Locally*, try and abort the oncoming boil by injecting into its depths 5 drops of a 1 in 30 solution of carbolic acid, or by the application of cataplasma kaolini (U.S. Pharmacopœia) or cataplasma salicylicum compositum (antiphlogistine).

When softening has appeared, it should be opened after freezing, and the cavity cleansed with warm carbolic dressing (about 1 in 30), and dressed with some simple dressing (*e.g.*, a little chloretone or iodoform sprinkled on boracic-acid ointment). Bier's suction bell will expedite the separation.

Constitutional Treatment.—The patient is to be put in the best possible hygienic conditions, so as to improve his health. If the boils show a tendency to appear in crops, a vaccine should be made from the pus and injections given. If this is impossible, then the stock staphylococcus vaccine should be used ; about 50 to 300 millions should be used every third to seventh day, according to effect. Crocker recommends most strongly half a wineglassful of fresh yeast night and morning.

Carbuncle—Definition.—An acute phlegmonous inflammation of the skin, with multiple openings, induration, sloughing of the subjacent tissue and of the skin.

Symptoms.—This affection is generally single, and affects the extensor surface, especially the neck, back, shoulders, or buttocks. It begins as a firm, flat, and painful inflammation of the skin ; it becomes red, tender, burning ; in ten days it is deeply seated, flatly convex, livid red, brawny. Softening in the middle is shown in the development of a number of pustules, which give way and show cribriform openings, and, lying beneath the skin, a dirty slough. There are considerable constitutional symptoms : fever, perhaps septic fever, perhaps rigors. Finally, the patient sinks from exhaustion or from some complication, or the slough separates and the wound gradually heals, leaving a considerable scar. It is apt to occur in the diabetic and the chronic alcoholic, in the aged and adult, and in those who are seriously run down in general health.

Pathology.—It has not the same lateral limitations as the boil ; it spreads along the planes of subcutaneous tissue ; the bloodvessels become blocked, and extensive necrosis occurs. The *Staphylococcus aureus* is the chief microbe found.

Prognosis.—This is serious in the debilitated, whether by diabetes, chronic alcoholism, or other exhausting affection. With a large carbuncle a patient is laid aside for several months, and may never be the same again ; it takes weeks for the large hole left by the slough to granulate up and the skin to heal over.

Diagnosis.—From a boil it is distinguished by its larger size, its extensive brawniness, its multiple openings, by its being single, and its position, and the severer constitutional symptoms. By the same characteristics it is to be distinguished from an ulcerating gumma, where there will be a history of syphilis ; from an anthrax pustule by the same signs and by the absence of the characteristic ring of blood-stained vesicles, the opportunity of infection, and the position on an exposed part. The *Bacillus anthracis* should also be found.

Treatment.—*Locally*, warm compresses wrung out of warm boracic or carbolic solution give some relief. It has been aborted by subcutaneous injections all round of warm carbolic lotion (1 in 30), but practically the opportunity of a suitable case appearing at a suitably early stage is rare. When softening has commenced, a crucial incision should be made, and warm boracic or carbolic compresses applied ; the wound is to be syringed daily, and all loose sloughs removed, expediting the process by cutting them away, or scooping them out with a sharp spoon. Rather severe bleeding may follow too energetic interference.

Constitutionally, the patient is to be put in the best hygienic conditions, and supported with the most easily digested and assimilated foods. If alcohol is ever required, it should be in minimum quantities, and soon stopped. Tentative injections of the staphylococcus should be tried.

Horn (*Syn.:* **Cornu**).—This is most commonly the result of a broken-down dermoid (Norman Walker). The treatment is to remove, and if necessary a wedge-shaped piece of skin may be cut out.

Sebaceous Cysts (Wens).—They are commonly met with in adults, and form in connection with the sebaceous glands and hair follicles. They are most common on the scalp, but are also met with on the face and neck, and on the genitals (see Diseases of the Scalp, Chapter XIX.).

Acute Abscess of the Skin.—This troublesome affection commonly arises in the axilla, or such localities where the skin is sodden and chafed.

The best **Treatment** is to bathe the part well with soap and water once daily, and then douche with a weak biniodide lotion ; after thorough drying, some antiseptic sanitary dusting powder is to be applied. When pus forms, it should be liberated.

Rosacea (*Syn.:* **Acne Rosacea**).—There are three stages of this affection : the first is marked by temporary flushing and, later, permanent redness and overaction of the sebaceous glands of the face ; the second by the formation of acne spots, and the small vessels become prominent

and varicose ; and the third by the development of fibrous tissue in the subcutaneous tissue of the nose, which, when excessive, produces nodulated, thickening folds, and pendulous masses on the nose, called **rhinophyma.** The dilated veins and the folds have to be treated surgically. The affection is limited to the middle two-thirds of the face.

1. **Dilated Veins.**—The simplest and most satisfactory method is to cleanse the nose with soap and water, ether, and some biniodide lotion ; then, using a sharp electric or Pacquelin's cautery, or Unna's microbrenner, quickly draw the sharp edge along the course of the vein. It is somewhat painful, but does not require an anæsthetic unless a large number have to be done at one sitting, when the repetition of the procedure becomes unbearable. A simple dressing is required for a day. The other method is by electrolysis. A constant current of about 5 milliampères is used ; the ordinary steel needle is fastened to the negative pole ; otherwise the iron would be oxidized at the positive pole, and leave a staining. The needle is inserted into the vein, and the current turned on ; it immediately commences to form minute bubbles, and after the lumen of the vein is observed to be obliterated, the current is stopped, and the process repeated elsewhere. About ten seconds are sufficient for each vein ; the process is longer, more painful, and more uncertain than the cautery, although Crocker prefers it. The positive pole may be used if provided with a platinum needle which does not oxidise.

2. **The Folds.**—The nose is prepared as before, and some Barker's solution injected, and the surgeon then pairs and slices away the exuberant tissue as required ; the folds are removed, and the sulci freed. The bleeding is free, but is easily stopped by folds of lint wrung out of hot lotion pressed against the parts ; some simple dressing is then applied.

Tuberculosis of the Skin.—The reason of the variety of manifestation of tubercle of the skin is not as yet understood ; we may surmise, but we do not know. The combinations and permutations of the many kinds of seeds and many kinds of soil on which the seed is sown give us an explanation, but not a scientific reason. We shall deal with them in simple order, beginning with the least complicated, and ending with that class of case in which the bacillus is not found, but in which the tuberculous diathesis is well marked, both by personal characteristics and also by family history.

1. **Inoculated Tubercle.**—This occurs in experiment on animals and from accident in human beings, as by cutting the finger with a broken sputum cup of a consumptive patient, or in butchers with a tuberculous beast. The part becomes red, swollen, indolent, and painless ; the lymphatics show a slight infiltration, and the glands show enlargement. Ulceration may occur with flabby granulations. The skin can also be infected from within, as from a suppurating gland or a carious bone ; a superficial abscess forms which breaks, leaving flabby granulations, a sinus, and a thin covering of vinous-coloured skin, undermined, beneath which a probe can be swept for over ½ inch all round. The bacilli are sometimes common and sometimes rare. This form is sometimes called "scrofuloderma."

Treatment.—The original cause is to be treated, and the patient put under the best hygienic conditions, so as to raise the resisting powers of the body. Locally, unless it is possible to sweep away the whole lesion, it is better not to indulge in the palliatives of scraping and such-

like treatment. Clean the wound or lesion thoroughly; dress daily with a little red lotion (zinc. sulphat., 2 grains; tr. lavandul. co., 12 minims water to 1 ounce); and inject $\frac{1}{10000}$ milligramme of tuberculin every tenth to twentieth day. The amount should be increased to $\frac{1}{5000}$ milligramme if the patient does not show a negative phase after the injection.

2. **Lupus Verrucosus** (*Syn.:* **Tuberculosis Verrucosa Cutis, Verruca Necrogenica**).—This is another form, really, of inoculation; it is found in post-mortem porters and butchers, and occasionally in surgeons. There is a slightly raised, infiltrated, and reddened base, with a warty growth covered more or less with a crust. It tends to enlarge at the border and to heal in the centre. There are no apple-jelly nodules, and it is liable to secondary infection from pus-forming microbes which produce a foul-smelling discharge. It attacks the limbs chiefly, but not exclusively, and is very chronic, sometimes lasting for years. It begins in a single lesion, but in time a number may form.

Etiology.—Crocker says that the idiopathic form often begins after measles.

Pathology.—The bacilli are commoner than in lupus vulgaris; the irritation gives rise to papillary growths, infiltration of the upper layers of the corium, and occasionally little caseating nodules, and even abscesses.

Treatment.—Application of the Röntgen rays and the suitable administration of tuberculin give ultimately the best results. Failing these measures, the application of a salicylic plaster to clean the parts, and then the destruction of the disease with fuming acid nitrate of mercury. Scraping undoubtedly causes the patient to run an undue risk of dissemination of the tubercle. A small nodule may be excised.

3. **Multiple Subcutaneous Tuberculous Nodules.**—These are met with on the extremities of children; they are indolent and painless, and generally burst and form ulcers or sinuses. It is recommended to scrape and pack with gauze, but in the light of recent knowledge it would be better to open, syringe, and dress with red lotion, and give tuberculin. Crocker also describes an acute form of miliary tuberculosis of the skin, but it is a rare affection. Bacilli are found in varying number,and the pus is mostly sterile for the ordinary pyogenic microbes.

4. **Lupus Vulgaris.**—This is one of the best-known tuberculous affections of the skin. It is chronic, spreads at the margin, tends to heal at the centre, and is asymmetrical. There are a large number of varieties, and its most characteristic feature is the presence of small apple-jelly nodules. It usually commences in childhood or youth, commonly on the face. Its first appearance is that of a brownish-yellow nodule the size of a hemp-seed; these are found to be collections of epithelioid and giant cells with the skin stretched over them; in colour they resemble slightly apple jelly, but also in the fact that they are of the same consistency, so that a probe can be sunk into them. They are best seen by pressing the blood away with a lens, when the colour and shape are evident. A number of satellite nodules form round the primary one, and so an area or plaque is formed; the epidermis may not break, and the part becomes reddish, uneven, and scaly. The disease spreads at the margin, and a scar forms at the centre; this is known as **lupus non-exedens.** The epidermis may break, and the part become affected with pyogenic microbes, and suppuration ensue, with a dark greenish crust; it is now known as **lupus exedens,** and is slower to heal, and does not leave such a fine scar as in the non-exedens. The disease may

spread (*a*) to the neck and other adjacent parts ; (*b*) to the gums, palate, larynx, etc., when the gums retract and the teeth loosen ; (*c*) the eyelids, when ectropion results ; (*d*) up the nostrils. It probably commences at the junction of the mucous membrane of the nostril and skin of the nose, and in a number of cases the mucous membrane has been found more extensively affected than the skin. In such cases a large number of ducts have been found slit for obstruction by the ophthalmic surgeon, due to the involvement of the opening into the nostril, even before the lupus of the skin was noticed. The mode of inoculation in children is obvious. (*e*) Into the vulva and vagina.

The commoner varieties are—(*a*) Great thickening due to the formation of much fibrous tissue and to obstruction of the lymphatic circulation of the part ; it is sometimes called " L. hypertrophicus," and is most markedly seen in the extremities, where a condition of elephantiasis is produced, but may occur anywhere. (*b*) A warty condition may ensue, and we have found lupus verrucosus and lupus vulgaris in the same patient. (*c*) When the fingers or toes are involved, the serious loss of the distal joints is produced, with much deformity ; this is called " lupus deformans," and resembles the destruction found in leprosy. (*d*) L. disseminatus : multiple patches in various regions. (*e*) L. serpiginosus, where one or more patches have spread in a sinuous or gyrate form.

Complications.—Erysipelas, which is apt to produce the elephantiasis form, abscesses, osteitis, crippling of joints, ectropion, obstruction of the nasal duct, etc. Epithelioma is apt to develop on either the scar or the unhealed lupus.

Pathology.—Lupus vulgaris is a granuloma developing in the corium and due to an infection of the *B. tuberculosis ;* the bacilli are sparse. In many there is a family history of phthisis ; in the " scrofulous " there is an early predisposition to ulceration.

Diagnosis.—Lupus vulgaris is marked by its chronicity, its asymmetry, healing at one end or in the centre, and spreading at the margin, and, above all, by the presence of apple-jelly nodules, brought into view by pressure with a glass slide or lens. These points distinguish it from L. erythematosus, leprosy, syphilis, rodent ulcer, psoriasis, eczema, epithelioma.

Prognosis.—There are few more unhappy sights than that of a young girl or lad with advanced lupus ; the disease is obstinate, and tends to recur after apparent cure. The chance of permanent cure is, roughly, proportional to the years of the patient and the smallness of the area affected ; the outlook, however, is much better now that the disease is better understood, and suitable treatment at once applied.

Treatment.—The patient is to be put under the best hygienic conditions possible ; all sources of irritation are to be avoided, the part cleaned, and treatment with the Finsen light or with the Röntgen rays begun and carried on by a trained specialist. The patient may need a course of tuberculin, to be ascertained by the examination of the opsonic index. Excision, erasion, scraping, multiple scarification, multiple punctures, the cautery, electrolysis, plasters of various kinds, pastes, caustics, are all better avoided. If the rays or light are not available, complete excision, if the lesion is small, and gentle cleansing, with perhaps removal of the prominent nodules by means of a dentist's drill rotated by the fingers, will do much to heal it ; but the patient should be told that it is not the best method, and that, although there is the fear of its return after any form of treatment, yet that any

mechanical disturbance involves the risk of the dissemination of the bacillus. Proper dosage with tuberculin seems to afford the best chance of preventing the growth of new invasions.

The following affections have been called **Tuberculides** or **Paratuberculoses**; they are closely connected with the tuberculous diathesis, but the bacillus has not been found :

Erythema induratum, or Bazin's disease.
Lichen scrofulosorum.
Lupus erythematosum.

The treatment is not surgical.

Molluscum Contagiosum.—This is a disease characterized by the presence and growth of small round papules with an umbilicated top and a peculiar shining, pearly colour. At first one appears, and then some weeks afterwards a number of others in an adjacent site. As its name signifies, it is contagious, and it is said to arise frequently from the Turkish bath. The infant's face and the mother's breasts are not infrequently affected together ; the old papules may wither away, but new ones keep coming. The centre is found to be composed of epithelium arranged in lobules ; the central ones are hard and oval, and were thought to be parasitic bodies. The disease occurs in animals.

Treatment.—The speediest and most efficacious means of getting rid of them is to snip them off with a pair of scissors curved on the flat ; formerly they were slit down vertically and the contents squeezed out ; if they are inflamed, a mild antiseptic lotion should be applied till the irritation is gone.

New Growths of the Skin.

Papilloma (*Syn.* : **Verruca, Wart**).—A wart is a small papillary growth with a horny covering. There are several varieties :

Verruca Vulgaris is found commonly on the hands of the young ; it is hard and sessile, with a flat top ; it is a closely packed collection of hard, horny epithelium. They are single or multiple. If at the edge of the nail, a wart may be painful.

Verruca Plantaris is generally single and found on the sole of the foot ; it is apt to be hidden under a thick covering of epithelium, and is distinguished from a callosity by its painfulness, and, when exposed, from a corn, by its component papillæ.

Verruca Plana occurs on the face in children, and sometimes on the backs of the hands ; they are supposed to resemble the papules of lichen planus.

Verruca Senilis is found chiefly on the back and arms. This form is generally pigmented ; associated with it is the **keratoma senilis,** a dirty brown incrustation, which is firmly adherent, with a slight papillary growth as base.

Verruca Digitata, with long papillæ separated down to the base, occur chiefly on the scalp.

Verruca Filiformis, the thin variety, is chiefly found on the face.

Verruca Acuminata, or the **Moist** or **Venereal Wart,** is found chiefly about the anus, perineum, glans penis, labia, and where the skin is kept moist. They are apt to get macerated and to become offensive ; they are produced by the irritating discharges.

Pathology.—Warts are clearly the result of some infection, but its nature has not as yet been determined; various microbes have been found, but none which have been proved to be the direct cause.

Treatment.—Various general remedies have been put forward from time to time, but they are so often disappointing that it is scarcely profitable to delay in order to use them. In all, but especially in the venereal, cleanliness is necessary; mechanical snipping off of the wart after freezing is probably the simplest and quickest. If in large numbers, the Röntgen rays, spread over a number of sittings, amounting in all to an hour, will prove successful. Ugly large warts will disappear under the application of the carbon dioxide snow. The horny layer should be removed by first soaking and then slicing off the outer part, after which the snow should be applied for from one-half to two or even three minutes—*i.e.*, till the root is frozen. A salicylic acid plaster, or collodion, preceded by the application of absolute alcohol, will effect the same process, but is much slower in action. Tying the base of the filiform wart and curetting the plantar wart have sometimes been resorted to. With the snow care must be taken not to cause a slough of the surrounding parts.

Moles.—Moles are epithelial growths, and are of many varieties; some are deeply pigmented, others less so; some are associated with nævi or with hair growth, others have little change except the increased pigmentation. They vary in shape and in size; they are apt to lead to malignant degeneration, especially if exposed to irritation.

Treatment.—If a mole is exposed to irritation, it should be excised at once and completely; caustics are not to be used. If there be hirsuties, electrolysis may be employed, but one rather dreads the irritation.

Adenoma.—Occasionally seen in connection with the sebaceous and sweat glands; frequently multiple, and occur usually on face or scalp (see Diseases of Scalp, Chapter XIX.).

Skin Cancers.—See Chapter VIII.

Affections of the Nails.

Contusion.—As the result of a crush, blood becomes extravasated beneath a nail, which may become shed and a new one take its place.

Foreign Body.—A splinter of wood or other foreign body may be driven beneath a nail, frequently that of the thumb, and gives rise to great pain, and perhaps sepsis. A V-shaped piece of the nail should be removed to permit of withdrawal of the body; the groove in which it lay should then be disinfected.

The following are some of the deformities to which nails are liable: **Onychauxis,** where there is increased thickness; **Onychogryphosis,** where the nail is twisted. The nail may also be spoon-shaped, and at times the nail-bed throws off enormous quantities of epithelium which collects under the nail and lifts it up, giving the resemblance as if the patient had been scraping mortar and had lifted the nail up from its bed. The nail may also be pinched at its root, giving it a fan-shaped appearance; this is seen in **hereditary syphilis.** In **onychia** the nail

may grow thick and transversely ridged, or the free border may become frayed. The nails may also become affected in **eczema, psoriasis, lichen planus, pityriasis rubra, favus, and ringworm.**

Treatment.—Where excision is not required, much improvement may be obtained by washing well with soap and water, polishing with a nailbrush, and rubbing in a resorcin ointment (5 grains to 1 ounce). Painting with strong ichthyol solution has been recommended.

Ingrowing Toenail.—Commonly met with in the great toe of young adults, and caused by tight shoes and want of care in cutting the nails. The edge of the nail presses on the inflamed tissue at its side, and may cause a break of the skin, with subsequent formation of granulation tissue and a fœtid discharge.

Treatment.—The nail and skin should be disinfected, and then the nail is cut square and a V-shaped piece removed from its centre, while a small piece of antiseptic gauze is tucked under the ingrowing edge of the nail. If this does not cure the condition, and in certain very advanced cases, a section of the nail and the overgrown tissue at the side has to be removed.

Subunguai Exostosis.—This is a bony tumour springing usually from the terminal phalanx of the great toe, which raises the nail. The growth may be chiselled away after raising a flap consisting of the nail and the soft tissues between it and the growth.

Malignant Disease.—Melanotic cancer and epithelioma are occasionally met with in connection with the nails. The finger or toe should be removed.

CHAPTER X

INJURIES

Contusions—Wounds : Methods of preventing wound infection—Abnormal scars—Gunshot wounds—Burns and scalds—Injuries caused by electricity—General effects of injury : Shock—Collapse—Syncope—Traumatic delirium—Fat embolism—Traumatic asphyxia.

CONTUSIONS.

A **contusion** is a bruise of the skin, with perhaps laceration of the underlying soft tissues, but no breaking of the skin ; when the latter occurs, a **contused wound** is present. It is brought about by force with a blunt object applied to the surface of the body, or by crushing. According to the direction of the force, the injury will be circumscribed and deep, or superficial and extensive. Subjects of scurvy, bleeders, and anæmic women, bruise easily.

Symptoms.—Ecchymosis is produced by the rupture of a number of small bloodvessels, and there is some discoloration of the skin. The blood may be extravasated widely in the cellular tissue, and produce deep discoloration of the part.

If the effused blood be enclosed in a space and is considerable in amount, a **hæmatoma** is formed, which, if it become encapsuled by proliferation of the connective tissue, forms a **hæmorrhagic cyst.** The blood in a hæmatoma is at first fluid, but becomes hard when coagulation takes place, the hardness beginning as a peripheral ring. The blood may become absorbed, organized, form a serous cyst, or suppuration may set in from the admission of septic organisms.

If lymphatic vessels are torn in a contusion, a **lymphatic** or **serous cyst** results from the accumulation of extravasated serous fluid.

There is swelling, pain, and redness over the contused areas, and slight fever ; where certain parts, as the testicle or head, are severely contused, there is considerable shock, and even collapse.

Treatment.—When seen immediately, the part should be raised and bandaged firmly over cotton-wool to prevent extravasation. If this has taken place, massage should be carried out ; but where blebs have formed, these must be dressed and allowed to heal first. Where great tension exists, incision under aseptic conditions should be carried out. The blood in a hæmatoma may be released by puncture with a needle. If septic conditions arise, they should be treated on general principles.

WOUNDS.

A wound differs from a contusion in that the skin or mucous membrane is broken, and there is therefore much greater danger of septic changes.

Wounds may be incised, punctured, or contused.

Incised Wounds are clean cuts made without bruising, such as an operation wound. They are marked by widely gaping edges and free bleeding. These wounds are usually made by a sharp instrument, but when a bone lies near the surface, as in the case of the skull, patella, or tibia, an incised wound of the soft parts may be made by a blunt weapon. When properly treated, an incised wound unites firmly and quickly; if it does not do so, it is due to lack of proper arrest of bleeding, to inefficient suturing, sepsis, or constitutional debility. If septic changes are taking place, it is shown by a rise of temperature, perhaps by a rigor, and by local signs of inflammation.

A fatal result may follow shock, hæmorrhage, or septic poisoning.

Punctured Wounds.—These are usually produced by long, narrow instruments. They do not gape, and there is little external bleeding. In these wounds the depth is greater than their length, and this constitutes one of their dangers, since it is often difficult to insure asepsis at their deepest part. Another danger is that deep structures may be wounded and closed cavities entered.

Contused Wounds.—These are produced by a blunt weapon, which tears and bruises the superficial area affected. The bleeding is slight, as the vessels have been torn and natural arrest of hæmorrhage facilitated. Gangrene of tissue may occur by the cutting off of the blood-supply of the part by the original injury, or by thrombosis from subsequent reactionary inflammation. Owing to the difficulty of very thoroughly cleansing the wound, sloughing of the bruised tissues may occur. A further division into **lacerated wounds** may be made, but it is largely artificial, since contused wounds are usually also lacerated.

Healing of Wounds.—This has already been described under **Process of Repair** in Chapter VI.

Treatment of Wounds.—Before entering into the question of the treatment of a particular wound, we will consider the whole subject of wound treatment in general.

The presence of pyogenic organisms being widespread, and wounds being prone to infection by them on account of the broken skin or mucous surface, it is obvious that successful wound treatment must aim at preventing their entrance, and, failing that, by counteracting their bad effects.

Whenever a patient presents a wound for treatment other than one inflicted under aseptic precautions—*i.e.*, a wound made by a surgeon through normal skin—it is well to conclude that already bacterial infection has taken place, but it is to be clearly understood that this is to be no excuse for careless admission of added infection. The student should remember that practically everything which has not been sterilized is septic; therefore, however carefully first aid may have been rendered after an accident involving a broken skin surface, the wound is septic when the surgeon sees it; indeed, the very agents used for cleansing and dressing the wound—as water and a handkerchief or piece of "clean" linen—may, and probably have, added their special contribution to the wound infection, though they may have removed

or excluded others. Cleanness, be it remembered, is not sterility, and that alone is surgical cleanness. Should the wound involve the mucous membrane of mouth or nose, the organisms normally present in such situations are an added source of danger.

When a wound is deliberately made, as in a surgical operation, organisms may be introduced from the operator's hands owing to inefficient cleansing ; from the patient's skin for the same reason ; from the instruments, sutures, ligatures, or swabs and dressings used in the course of the operation, which have not been carefully prepared ; or from the air. It sometimes happens that, though scrupulous care has been taken, yet pus develops after an operation. This is probably owing to infection from within, the organisms having been carried by the blood-stream to devitalized tissue from some infected area elsewhere in the body.

Treatment of wounds on the battlefield has changed in detail from time to time. In the present war experience has taught that iodine or some of its preparations is the best substance to use as a first application for wounds.

Methods of preventing Wound Infection—Definitions.—Sepsis : Infection with pyogenic organisms.

Septic : The condition of the tissues produced by sepsis.

Asepsis : The condition in which bacteria are absent.

Aseptic : The method employed for preventing wound infection without the use of chemicals.

Sterilization : Killing bacteria by heat. The method employed under the aseptic régime for dressings, ligatures, and instruments.

Antiseptic : The method employed for the destruction or inhibition of bacteria by means of chemical agents. The agent so used.

Antisepsis : The condition in which bacteria have been removed or their growth arrested by the antiseptic method.

The Aseptic Method.—This aims at the prevention of wound infection, chiefly relying on heat for the destruction of germs, and using no chemicals—at least, in contact with any wounded surface. Thus, instruments are boiled ; dressings, etc., treated with steam ; while skin surfaces are excluded from contact with wounds.

The **objections** to the method : Heat cannot be applied to sterilize the air or the skin, nor can the skin surfaces or the atmosphere be entirely cut off from wound contact.

The Antiseptic Method.—This was the earlier of the two systems, and that introduced by Lister. It aims at the destruction of bacteria chiefly by chemical agents. The skin and wound are treated with these bactericides ; instruments, ligatures, etc., are prepared by soaking in them ; dressings by being impregnated with them ; the air by being sprayed with them.

The **objections** to the method are that chemical agents which will destroy bacteria on the surface of the skin cannot do so if they are under the superficial layers or covered with fat or albuminous material ; while the agent which is powerful enough to destroy the organisms in these situations will be injurious to the tissues.

It is not a wise thing to follow any stereotyped method or system in dealing with the human body, which presents such diverse conditions under apparently similar circumstances. No one nowadays adheres strictly to either the aseptic or the antiseptic method, but rather combines the two, accentuating one or the other, as the circumstances or

the state of the wound demand. At the same time, so far as the preparation of the patient's skin, the surgeon's hands, instruments, and dressings are concerned, a definite system is pursued, which should become second nature to the student. This system, which we may term the "modern method," is a judicious combination of the two procedures.

The Modern Method.—We now recognize and take into consideration in the treatment of wounds and the prevention of their infection, three main factors—*i.e.*, **the resistance of the normal tissues; the exclusion of bacteria; the destruction of bacteria by artificial means.**

(A) **Resistance of Normal Tissues.**—It must be clearly understood that the most perfect surgical toilet will not be able to exclude all organisms from a wound; but that is not necessary, since Nature has provided very efficient resistance to infection and its results. This is inherent in all normal tissue, but differs in strength in different individuals. The chief modifying factors of this resistance are—

Age.—The old are more liable to infection than the young, probably from defective circulation.

Circulation.—Vascular parts heal better and more quickly than non-vascular parts. Those with a good general circulation are better subjects than those with a poor one. Those conditions and diseases with which are associated defective circulation, or circulation of morbid blood, are also those in which infective processes are most likely to occur, as in gangrene and diabetes.

Local Condition of Tissues.—The condition of the tissues about the wound have a good deal to do with resistance or non-resistance to infection. Thus, a contused wound is more liable to infection than an incised one; much handling or dragging of tissue, the use of blunt instruments, the cooling of the temperature of the part far below the normal, and the application of strong chemicals, are all prone to make the part liable to infection. Those tissues which have most resistant force to infection are also those which have least resistance to the bad effects of strong chemicals. Thus, serous surfaces are strongly resistant to infection, but are easily injured by chemicals; while synovial surfaces, muscle, and bone, are comparatively non-resistant to infection, but are not easily injured by chemicals, if the solution is not too strong.

Artificial Immunity.—The injection of certain antitoxic sera, vaccines, and materials for causing leucocytosis (as nucleic acid and sodium cinnamate), increase the power of resistance to infection.

(B) **Exclusion of Bacteria.**—In order to prevent wounds, especially operation wounds, being infected by germs from the surgeon's hands or the skin of the patient, both have to be purified. It must, however, be remembered that, owing to some of the bacteria lying deep in the epidermis, follicles, and glands, no preparation can absolutely insure non-infection. For this reason, many surgeons prefer to wear sterilized rubber gloves for all operations to protect their patients, while some only wear them for septic operations to protect themselves.

Preparation of the Surgeon's Hands.—The nails are trimmed closely, and the hands washed well with plain or antiseptic soap and a nail-brush. They are then cleansed for several minutes with hot running water and a sterilized nailbrush, using pumice-stone to remove loose epithelium. Ether or alcohol (methylated spirit) are then applied in order to remove grease and to dehydrate the skin. Finally, the hands are washed with biniodide of mercury (1 in 1,000) for two minutes.

The antiseptic used may vary with the opinion of the surgeon as to its efficacy or its hurtful influence on the skin of his hands.

Those most commonly employed are—

Biniodide of mercury 1 part, alcohol 400 parts, water 100 parts; this solution has the advantage of fixing the bacteria as well as killing them. Lockwood has pointed out that by using the alcoholic solution of mercury and a 1 in 500 watery solution alternately, the mercury penetrates the skin and enters into close association with it.

Carbolic acid (1 in 40) and perchloride of mercury (1 in 1,000) were formerly more used than now, since it has been found that they produce coagulation of albumin, and so prevent their penetration beneath the surface. The biniodide of mercury does not produce coagulation.

The whole process of hand cleansing and preparation should take about ten minutes.

Preparation of Patient's Skin.—The part should be shaved if any hair exists.

It is then well washed with soap and water. Fat and grease are removed by alcohol or ether, and this followed by an application of 1 in 1,000 biniodide of mercury.

The part is then covered with layers of sterilized gauze, which are left in position till the operation, before which the part should again be washed with an antiseptic or painted with liniment or tincture of iodine. The field of operation is surrounded by sterilized towels clipped to the patient's skin, or to the edges of the wound.

Sterilization of Instruments.—These should be boiled in a fish-kettle for about fifteen minutes. Bicarbonate of soda preserves them from rust, and the boiling-point is higher than that of plain water. Different methods are employed for the sterilization of cutting instruments by different surgeons; some boil them with the other instruments, protecting their edges by rolling some gauze round them, others immerse for ten minutes in 80 per cent. spirit, for one minute in pure carbolic, or in pure lysol for three minutes. Boiling is the surer treatment. Catheters, other than metal ones, should be immersed in 1 in 5,000 biniodide of mercury.

Preparation of Ligatures.—All non-absorbable ligatures, as silk, silkworm-gut, thread, or wire, may be boiled; repeated boilings, however, spoil thread, silk, or gut. Catgut may be prepared in various ways, such as boiling in alcohol or carbolic acid, etc., or by steeping in juniper oil for a long period, and storing in 1 in 1,000 solution of perchloride of mercury in alcohol; but the most satisfactory and simplest method probably is the iodine one. The gut is steeped in a solution of iodine 1 part, iodide of potassium 1 part, and distilled water 100 parts, in which it is kept for eight days, when it is ready for use and may be transferred to a closed, sterile vessel. The solution may be varied, as tincture of iodine 1 part, and proof spirit 15 parts, in which it may be kept indefinitely without detriment.

Preparation of Dressings, Towels, etc.—These are best sterilized by high-pressure steam. This process requires about two hours, and is carried out in a special apparatus; a temperature of 120° C. can be obtained, the steam reaches the material through holes in the sides of the metal drums. These can be closed before removal from the sterilizer, and the dressings, if need be, transported to a distance. A great advantage of the modern sterilizer is that the dressings are dry when removed from it.

Ordinary gauze is the dressing now chiefly used when a sterilizer

can be employed; if not, a gauze impregnated with some antiseptic, as the cyanide of mercury and of zinc (bi-cyanide gauze), or iodoform. The former is often used where sterilization of the skin cannot be assured, the latter for packing open and tuberculous wounds. One of these gauzes, together with some sterilized wool, forms the dressing employed for most wounds.

Preparation of the Air.—So far as possible, the air where wounds are to be made or treated, as in an operating theatre, should be pure. This is attained by having no surfaces where dust can accumulate and by keeping everything scrupulously clean. In some cases the air is filtered. Draughts should be avoided, since, if the air is still, bacteria sink to the floor.

(C) Most surgeons wear a mask of gauze or linen to cover the mouth, nostrils, and scalp. This prevents infection from these sources.

Destruction of Bacteria.—Where a wound has become infected, care must be taken, when it comes under expert hands, that no further poisoning takes place. Where there is much ingraining of dirt and bruising of the tissues, all hopelessly ragged pieces of skin, muscle, or bone, should be removed, and any tissue which is impregnated with dust or other foreign body. Antiseptics should be used, but they should not be too strong, and where solutions are employed, the devitalized tissues should be subsequently dried with sterilized gauze. Such a wound should not be stitched closely; but it is a mistake to leave a large, gaping wound, even if contused; so long as proper drainage is insured, stitches need not be feared, but undue tension must be guarded against. The wound should be treated by the open method, and packed with iodoform gauze.

The following is a list of special antiseptics, with the reason for, and the time for, their use:

Iodoform, in the form of crystals or as iodoform gauze, is useful in the treatment of tuberculous abscesses, bone cavities, and open wounds. Its power lies in liberating free iodine when disintegrated in the tissues. It is not a strong germicide, but promotes healthy granulation by neutralizing the products of bacteria. As organisms are capable of existing in the dry powder, it should be sterilized by boiling or by immersion in 1 in 20 carbolic lotion.

Cases of poisoning due to absorption, especially in children and weakly persons, have been reported. The condition is evidenced by high temperature and pulse-rate, dry tongue, and mental excitement or depression; while the presence of the drug may be detected in the urine by adding an equal volume of hydrochloric acid, and pouring on the surface of the fluid a small amount of chloride of lime solution. At the junction of the fluids a brown ring is formed, which turns blue on adding starch solution. Some patients develop an iodoform rash.

Aristol is sometimes used in preference to iodoform, when the smell of the latter is objected to.

Peroxide of hydrogen is a useful antiseptic for deodorizing and cleaning septic wounds and cavities; it contains oxygen in feeble combination, and acts by parting with it to oxidize the tissues.

Protargol acts as an astringent and antiseptic, employed in the strength of 1 to 4 grains to the ounce; it is largely used for application to the mucous membranes.

Carbolic acid was the original antiseptic used by Lister, and is still being largely employed. It is used chiefly in 1 in 20 and 1 in 40 solutions, the former for instruments and the patient's skin, the latter for

the surgeon's hands. It is somewhat irritating to the skin, and when used pure, or in strong solutions, produces necrosis of the superficial layers. It may produce poisoning from absorption, colouring the urine green and giving rise to nausea, vomiting, and giddiness. It may be detected in the urine by adding a solution of perchloride of iron, which gives a blue colour

Mercury.—As the perchloride (1 in 1,000) and the biniodide (1 in 1,000) is widely used, the latter has to a great extent replaced the former, being more powerful, less irritating, and allowing more permeation owing to its not forming any coagulation of albumin. It has the additional value of not tarnishing instruments. Corrosive sublimate poisoning produces abdominal pain, diarrhœa, and vomiting, and may be followed by collapse and death.

Iodine, as liniment or tincture, is now largely used to disinfect the patient's skin before operation.

Boracic acid is a very valuable mild antiseptic, used for washing out the bladder, as a fomentation, and for steeping septic wounds, being non-irritating and non-poisonous. A saturated solution of the powder is used.

Permanganate of potash is useful for free irrigation of mucous membranes, as the urethra and vagina, etc. The crystals should be dissolved to form a 1 in 5,000 solution.

Formalin is a very useful disinfectant for rooms, one or two tabloids being evaporated over a stove. It does not tarnish silver or gold articles. The drug is also employed in various proprietary articles, and as a deodorant.

The number of antiseptics in use are now legion, but the above are those most commonly employed, either singly or in combination, for surgical purposes.

Treatment of Particular Wounds—Incised Wounds.—Hæmorrhage is arrested and the wound washed with a mild antiseptic, or with sterilized water. The edges should be accurately stitched together, avoiding any inversion.

If a wound is very deep, the under layers are united with buried catgut sutures. The skin is best united with silkworm gut or horsehair. The stitches may be continuous or interrupted. If there is difficulty in bringing the edges together, relaxation stitches may be used. These are inserted at some distance from the edges of the wound, and should be removed in four days ; the coaptation stitches remain in for about ten days, except in the face, where they should be removed in three or four days in order to avoid stitch marks, and because the tissues heal more rapidly owing to the large blood-supply.

It is not necessary to drain incised wounds unless in deep infected ones which cannot be rendered aseptic, or where pressure cannot be applied.

Sterilized gauze and wool should be applied as a dressing, and the part firmly bandaged. When necessary, splints may be used to give rest to the part.

Infection of a wound after treatment will be indicated by local pain and redness, and a rise of temperature. The wound should be opened again, washed out with peroxide of hydrogen, and drained.

Punctured Wounds.—The wound should be sterilized for its whole depth, and any foreign body which may be found to be present removed ; in some cases, when the wound is very deep, it may be of advantage to locate the foreign body by means of the X rays. It is

frequently necessary to enlarge the wound in order to treat it satisfactorily. If a bloodvessel is punctured, it should be divided and ligatured. Any severed structures, as tendons, nerves, etc., are to be united. The wound is dressed in the ordinary way.

Contused Wounds.—It is frequently necessary to give an anæsthetic in order to clean these wounds, or where a limb is injured, and there is a marked septic condition, to place it in a tank with warm boric lotion, in which it may remain for several days; this has the effect of washing away much of the toxins and diluting what remains in the wound, so as to make it more or less innocuous. All ragged tissue should be cut away, and the raw surface cleaned with peroxide of hydrogen; avoid treatment with strong antiseptics and rough scrubbing. The wound is then packed with gauze and the limb placed on a splint.

The question may arise in these cases whether to amputate or not. The points which indicate its necessity are—(*a*) Destruction of the main artery, indicated by loss of pulsation and coldness beyond the injury. (*b*) Laceration of important nerve trunks will add to the risk of gangrene, and increase the demand for amputation. (*c*) Destruction of large masses of soft tissues. (*d*) Severe septic symptoms. Each case must, however, be judged on its merits, since the age or debility of a patient, or the distance of an injury from the heart, may point to the need for amputation when an equal injury in a different situation or in another patient would render it unnecessary. If perfect asepsis can be procured, most severe contused wounds may be recovered from without amputation.

ABNORMAL SCARS.

After healing of a wound, there may be extensive **contraction** of the scar, leading to deformity, which has to be met by division of the scar and skin grafting. A scar may also be **painful,** owing to the involvement of nerve endings, **discoloured, depressed, ulcerated,** or **weak.** In all these conditions the best treatment is to excise the scar and, if necessary, skin graft.

Keloid.—This is a vascular, fibroid scar which is raised and often has radiating processes. It is said to be more frequent in tuberculous patients and where strong antiseptics have been used, and may be produced sometimes by the involvement of a subcutaneous muscle which constantly drags upon the forming scar. The keloid should be removed, but may, and does often, return.

Malignant Growth occasionally occurs in a scar, probably in those who are in some way predisposed. It is treated by excision.

GUNSHOT WOUNDS.

Nature.—Gunshot wounds are usually of the nature of punctured wounds, though in some cases they are also contused or lacerated.

Contrast in Civil and Military Practice.—As seen **in civil practice,** gunshot wounds are usually accidental, homicidal, or suicidal; they are inflicted by a great variety of weapons, most commonly by shot-guns or various types of revolvers, less commonly by service rifles; they are mostly inflicted at short ranges, and are therefore accompanied by actual burning or laceration of tissue by the explosive used; and they can usually be treated under favourable conditions of surgery.

In war the contrast is marked. Under service conditions, gunshot wounds are caused for the most part by the same type of missile, at long ranges, on young men in the prime of life and in good training, but who may be worn out by the exigencies of long sieges or insalubrious campaigning; and they have to be dealt with under the most unfavourable conditions, due to overwhelming numbers, the impossibility of aseptic work, exposure, want of proper food and nursing, and the imperative necessity of early transport, often over long distances.

Factors influencing Wounding Effects.—(*a*) **Velocity** is the factor which gives a bullet its penetrative power. Pellets from a shot-gun at 40 yards will barely penetrate the skin. The old round leaden bullet lacked penetrative power, and was often turned aside in the body by bone, or even by tendons and aponeuroses. Most modern service rifles have a high muzzle velocity, the aim of modern small-arm makers being to give as high a velocity as possible at all ranges by the use of high explosives.

(*b*) **Weight** is closely associated with velocity. The striking energy of any moving body is measured by the product of the mass in pounds by the square of the velocity in feet per second. It is to be observed, therefore, that, while the heavier missiles will *cæteris paribus* strike the heavier blow, increase of weight has less influence on striking energy than increase of velocity. And accordingly the tendency of late years has been to make up for progressive diminution in the weight of the bullet by an increase in its velocity.

(*c*) **Cross Sectional Area.**—The larger the striking surface, the greater is the effect of the blow. Entire shells or large fragments of shell produce extensive lacerations and contusions, or even carry away portions of the body. In this respect the small-bore bullet is wanting in wounding or "stopping" power, and various devices have been employed to make up for this defect. One is so to manufacture the bullet that it breaks up or becomes deformed on impact, and so offers a large wounding surface to the tissues. These so-called "expanding" bullets have been used against wild animals or savage foes, but have been ruled out of use in civilized warfare by common international consent. The latest device for increasing the area of impact is to make the bullet with a light point, so that it tends to turn over and make lateral impact when the light tip engages in the tissues. Most nations are now adopting a missile of about $\frac{3}{10}$ inch in diameter, which has a light pointed tip, and which may be regarded as the last word in the evolution of the small-arm missile.

(*d*) Finally, **the Tissues themselves,** both in their vital importance and their resistance to the bullet, have a great influence on wounding effects. Thus, the more vitally necessary tissues, such as the medulla oblongata, the heart, and the aorta, are gravely affected by a missile which would probably have little effect upon the lung or the muscles of the buttock. And a resistant structure like the shaft of the femur will absorb more of the energy of the bullet, and undergo a much higher degree of disruption, than the liver, a soft and semifluid organ.

Local Effects of Gunshots.—The **larger and slower-moving missiles,** such as shell or shell fragments, shrapnel bullets, and the like, have but little penetrative power. They inflict large lacerated and contused wounds, and have a tendency to lodge in the tissues and to carry in fragments of clothing. These wounds are nearly always septic, and are accompanied by a high degree of shock. Hæmorrhage as a rule is slight, and healing slow. **Small-bore bullets** produce very characteristic injuries. The **wound of entry** is as a rule circular or oval, with loss of substance, as if cut out with a punch. The edges are infolded and blackened, and there is an area of ecchymosis round them. **The track** in the soft parts is a direct line from entry to exit, provided the patient is placed in the same position as when he was hit. The small-bore bullet is hardly ever turned aside, even by bone. There is complete destruction of all tissues in the actual track, and its vicinity is usually gorged with blood. If resistant parts, such as fibrous aponeuroses, etc., are met with, there is a sudden enlargement of the diameter of the track. This is seen most typically in the case of compact bone, in which a high degree of comminution always occurs. The bullet imparts some of its energy to the bone fragments, and drives them before it as secondary missiles, lacerating the tissues of the exit section of the track, and even driving some fragments through the skin in some cases. Wounds of this type are spoken of as "explosive" wounds. The healing of the track is often accompanied by the formation of a very firm eschar, by the contraction of which neighbouring structures may be seriously affected. **The exit wound** varies greatly in size. In some cases it may be no larger than the entry; in other cases, and especially when bone lying superficially is hit, it may be irregular, lacerated, and several inches in diameter, with protruding muscles, tendons, and other soft parts bound together by blood-clot.

Early Symptoms.—(*a*) **Pain** is usually present in some degree, but may frequently be altogether absent in the excitement of battle, or, exceptionally, so severe as to threaten life. It depends largely upon the extent and situation of the injury. Thus, the pain of flesh wounds is not severe, and has been likened to a smart blow with a cane. It is felt in the skin wounds, and not in the track. The pain of bone wounds and of wounds of large nerve trunks is severe and lasting. Shell wounds cause severe pain at first, rapidly followed by numbness. In multiple wounds pain is only felt in the most sensitive part hit.

(*b*) **Shock** of the general and constitutional kind is a well-marked feature of gunshot wounds, and especially of those of the chest near the heart, of penetrating abdominal wounds, of wounds of the central nervous system, especially the spinal cord, of shell wounds, and of bad bone smashes. It depends, however, to some extent upon the idiosyncrasy of the individual, upon his preoccupation, upon his conviction that he has received a mortal injury, and upon the exaltation of victory or the depression of defeat. In addition to general shock, there is also noted in connection with gunshots a complete loss of functional capa-

city in the part injured, loss of sensation, and muscular paralysis. It is most marked in wounds inflicted at short ranges, and at or near the wound of entry. Its onset is rapid, and its duration from a few hours to a day or more. While in this condition of **local shock,** the vital resistance of the tissues to septic infection is lowered, and ligature of vessels is apt to lead to gangrene. The muscular paralysis also obscures deformities, and makes the proper adjustment of splints to fractures more difficult. Local shock seems to be almost peculiar to gunshot injuries.

(*c*) **Hæmorrhage** externally is neither copious nor fatal, except in the case of superficial vessels. This has always been a characteristic of gunshots. The tendency in the limbs, even in the case of the largest trunks, is to cease bleeding, with the subsequent obliteration of the vessel, the formation of traumatic aneurisms, or the development of arterio-venous communications. Internal bleeding, on the other hand, is exceedingly common and fatal. The unsupported vessels of the body cavities bleed freely without check, and are calculated to be responsible for from 85 to 90 per cent. of deaths on the field of battle.

Clinical Course.—In the subsequent course of gunshots **sepsis** is the great danger. If it could be entirely prevented, wounds of the limbs would present few terrors. But unfortunately, though immense strides have been made in the last three decades, perfect asepsis in military surgery remains an unrealized ideal. Sepsis arises as a rule from without, from the skin and clothing of the patient and his attendants, or by the impaction of foreign bodies in the wound. But it may also arise from within, as, for example, when a bullet traverses any part of the alimentary tract, and lodges in or passes through parts beyond. The bullet itself has been shown experimentally to be practically sterile after being fired. Sepsis is naturally associated most commonly with the larger varieties of wounds, the so-called "explosive" type becoming almost invariably septic. But simple flesh wounds, owing to the small entries and exits of the small-bore bullets, the slightness of bleeding or serous discharge, and the tendency to automatic closure of the walls of the track, are nearly always sterile, if they are not injudiciously probed or handled.

Characteristic Effects on Various Tissues.—(*a*) **Bloodvessels** illustrate conspicuously the extremely localized nature of the injury which a small-bore bullet produces, owing to its small diameter and immense velocity. The old slow-moving bullets often pushed vessels aside. There is evidence that this occasionally happens in the case of the modern missile, but far more often the vessel is cleanly perforated, or has a piece punched out of its side. When completely divided, retraction of the vessel into its sheath can occur, and the natural method of hæmostasis can take place. But when the vessel is notched or perforated, no retraction takes place, bleeding goes on interstitially until the pressure in the tissues outside is equal to that in the vessel, and a traumatic aneurism is formed. The track is so small that very little blood is forced along it to the surface, and, moreover, change of position of the man after being hit makes the track tortuous. When an artery and a vein lying side by side are both notched or perforated, an arterio-venous communication results. This is seen only in the limbs. In the vessels of the mesentery and omentum, or in those of the body walls, bleeding is usually continuous and fatal.

(*b*) **Bone** of the **cancellous** kind, and all flat bones, are usually cleanly perforated by small-bore bullets, leaving tracks which heal like wounds

of soft parts. Comminution only occasionally occurs. **Compact bone,** on the other hand, is severely affected. The part actually touched by the bullet is reduced to bone dust and carried away. And from the point of impact fissures radiate abruptly to the surfaces of the bone, with larger cracks occasionally running the whole length of the bone, and even involving neighbouring joints, though this is not so common as it used to be in the case of the larger-bore bullets. All gunshot fractures of bone are in the first instance compound, and usually comminuted, but the bullet tracks in the soft parts are so small that if asepsis can be secured the fact of the fracture being compound does not prejudice consolidation to any great extent. Union in gunshot fractures is usually slow, and is accompanied by the formation of an unusual amount of callus. But, on the other hand, it is usually complete, non-union being extremely rare. A high degree of deformity is usually seen in the lower extremity, due partly to the comminution, partly to the unfavourable conditions of treatment.

(*c*) Of the **nervous tissues,** peripheral **nerves** may be divided, contused, or notched by bullets, and show the usual signs of physiological discontinuity. They may also be secondarily involved in the firm, hard scars of bullet tracks which pass near them. But nervous tissues may also be gravely affected by the mere passage of a bullet in their vicinity. Concussive effects are seen, due to radiation from the track of impulses set up by the energy of the bullet. Complete loss of conducting power follows without any gross lesion of the nerve itself, and in the worst cases it is probable that degeneration and regeneration of nerve fibres takes place. No part of the nervous system shows this phenomenon more markedly than the **spinal cord,** the bony sheath in which it is enclosed conveying the destructive radiations with great readiness. The body of a vertebra may be cleanly perforated with little actual bone destruction, and yet the cord near it is as completely disorganized as if the bullet had traversed it. Of gunshots of the **brain** it may be said generally that, however favourable they may appear to be at first (and many cases of complete perforation of the head, with few or no early symptoms, have occurred), yet later grave signs of injury, such as traumatic epilepsy, mental failure, local paralysis, abscess of the brain, etc., almost invariably develop. The unsupported inner table at the site of entry undergoes fine comminution, and fragments are often found at a depth of 2 inches from the surface. At short ranges the amount of destruction may be enormous, the cranium behaving like a closed cavity full of fluid, and bursting along the sutures of the skull. Superficial perforating wounds are by some military surgeons considered to be of more importance than deeper ones, inasmuch as the cortical areas are more likely to be destroyed. But the general rule undoubtedly is that the nearer the track is to the base of the skull, the more fatal it is. Fractures of the base differ from the " bursting " fractures of civil life, in that they occur at any part of the base, and so do not show the typical basal symptoms. Those in the middle and posterior fossæ are the most dangerous.

(*d*) **Solid viscera,** such as the lung, liver, spleen, and kidney, usually show clean perforations, the only danger from which is hæmorrhage, and then only when the track passes near the larger vessels of the hilum. Exceptionally at short ranges the so-called " splash " effect is seen, the substance of the viscus undergoing a high degree of laceration and pulping.

Wounds of the **heart** when its cavities are perforated prove almost

invariably fatal, but when the musculature alone is involved, recoveries have been known to take place. In one case a naval officer lived for ten years after a gunshot injury of the heart, the bullet post mortem being found embedded in the base of the heart between the aorta and pulmonary artery.

Hæmorrhage and peritonitis are the great danger in wounds of the **hollow abdominal viscera.** But perforation is by no means invariably followed by peritonitis. The small openings may be closed by prolapse into them of the redundant mucous membrane of the intestinal tract, giving time for the formation of defensive adhesions to neighbouring parts. The mobility of the parts involved and the amount and fluidity of their contents are of great importance. The fixed ascending and descending colons, with their more solid contents, may be wounded without extravasation, while the more movable small intestine, sigmoid, and transverse colon, with their fluid contents, are much less likely to escape. Wounds of the small intestinal area also are very often multiple. Wounds of the large intestine in the area uncovered by peritoneum are very fatal, owing to the virulent cellulitis set up. The same remark applies to the non-peritoneal surface of the bladder.

Treatment.—In the circumstances under which the majority of gunshot wounds are first seen—*i.e.*, in warfare—very little can be done until the patient has been removed to a fixed hospital. It is this need for early transport which exercises so disastrous an effect upon cases of hæmorrhage, intestinal perforation, fractures of long bones, and the like. But so impossible is it to insure asepsis or any approach to it, that operative measures of any importance should never be attempted except under pressure of immediate danger to life. Pain and shock should be met by such means as are at hand. This resolves itself into the routine administration of morphia, such hot drinks—Bovril, etc.—as can be rapidly prepared in the field ambulances, and the **cautious** administration of alcohol. External hæmorrhage can usually be checked by pressure, firm bandaging, and position. The use of the tourniquet, especially in unskilled hands, is much to be deprecated, as a long time may elapse in modern battles before more efficient hæmostases can be applied. Fractures should be firmly splinted with a view to transport, not too much time being wasted on attempts at reposition of the broken ends. And by far the most important indication is to dress the wounds at once so as to keep them aseptic. For this purpose each soldier is provided with a packet of sterile gauze and bandages, constituting a first field dressing, and he is instructed in peace-time in the proper handling and application of it. The skin area round the wound should be kept as dry as possible, and the skin bacteria fixed by iodine or one of the gummy solutions so highly recommended by German military surgeons. The drawback, however, to the use of prepared fluids of any kind is that a sufficient quantity cannot as a rule be provided when the wounded may be numbered by thousands.

At the fixed hospitals as a rule all the usual possibilities of aseptic ritual, good nursing and feeding, skiagraphic installations, and so on, are assured, and wounds can be handled on the ordinary lines of surgery. Wounds of **bloodvessels** should be treated on the ordinary lines. The smaller can often be controlled by pressure; the larger should be cut down upon and tied locally. But as a rule external bleeding is replaced by the formation of traumatic aneurisms and arterio-venous communications. Traumatic aneurisms should be

treated by local ligature, and in the case of aneurismal varix or varicose aneurism ligature of the artery above the opening into the vein or sac usually suffices for cure. Wounds of **nerves** should not be interfered with too soon. The track should be allowed time to completely cicatrize, and, moreover, delay will settle the question as to whether the nerve is actually injured or merely concussed. If a divided nerve is found in the course of an operation performed for other reasons, it should, of course, be sutured; but secondary suture may be safely left till three months at least after the wound has healed and all danger of sepsis is long past.

In gunshots of **bone** the cancellous, flat, and round bones are usually cleanly perforated without splintering, and rarely require more than keeping clean and dressing like a wound of the soft parts. In adjusting splints to gunshot fractures of the long bones, regard must be had, first to the large size of the exit wound in many cases, which will require a large amount of dressing and a most careful management to prevent sepsis; then to the high degree of comminution, which means an unusual degree of mobility of the broken ends, a liability to subsequent deformity, and a tendency also to the necrosis and separation of dead fragments, often after long intervals of time. It is for this last tendency that early operation upon the exit side of the track is often recommended, for the purpose of removing separated or dead fragments. In spite of the above-named disadvantages, and in spite of the fact that union is always very slow, gunshot fractures as a rule consolidate well. Special attention in splinting them should be given to securing rigid fixation with extension, owing to the extreme mobility of the broken ends.

In gunshots of the **head** the scalp should be shaved and cleaned, and the apertures both of entry and exit should be opened up, and all bone fragments removed. Both openings should be dealt with, because it is often impossible to tell which is entry and which exit. Fragments may be found lying 2 inches below the surface, and even beneath the lateral edges of the bone wound. Cerebral abscess is a common result of sepsis, and is usually superficial and in the track of the bullet. It is easy to find, but very difficult to drain properly. Hernia cerebri is another result of sepsis, and may be met by painting the protruding mass with alcohol or formalin, and applying mild pressure.

Gunshots of the **chest,** when not in a vital area, usually heal well and rapidly. The most important complication is hæmothorax, which is usually due to a lesion of a vessel in the thoracic wall, rather than to visceral injury. Transport has an exceedingly unfavourable effect on this class of injury, and should be avoided if possible. As a rule, strapping the affected side or firm bandaging of the whole chest is sufficient, the blood undergoing slow but complete absorption. Only under circumstances of urgent dyspnœa and cyanosis should aspiration be performed. Empyema is not common, except as a result of injudicious aspiration. When it occurs, it should be opened and drained in the usual manner.

Gunshots of the **abdomen** present remarkable contrasts. Many cases of undoubted perforation of the abdomen heal, with few or no symptoms. The ordinary rule in civil practice would be to explore as soon after the injury as possible. But as a rule in war cases cannot be operated upon soon enough to do any good, and even if seen early, the extent of the injury may be such (some twenty perforations of the intestines, with wounds of vessels and of solid viscera, have been found)

that operation fails. It was found in South Africa that expectant treatment gave the patient the best chance on the whole.

[The present war has shown that indiscriminate expectant treatment of abdominal wounds is not a success. If the wound is a clean bullet one with small apertures of entry and exit, and without any evidence of internal hæmorrhage and extravasation, then the case may be treated by the expectant method—namely, nursed in the Fowler position, with abstinence from food and the administration of opium. Where there are large wounds of entry and exit, with signs of internal hæmorrhage or extravasation and absence of liver dulness, then the case should be operated on, if the general condition is favourable. as soon as it can be got into proper surroundings. As a rule, shrapnel, bomb, and shell wounds cause great injury to the viscera, and are septic in character; in these wounds, therefore, operation gives the best chance of recovery if the patient is able to bear it. In such cases it is often advisable to excise the abdominal wound. If, however, the case is not seen until late and peritonitis has already set in, the best plan is to drain from the suprapubic region by means of a tube passed to the bottom of the pelvis, and to have the case nursed in the Fowler position.—Ed.]

A rigid separation of septic from aseptic cases should be insisted on where large numbers of wounded are being treated. It is the former class which will give the great majority of cases and fatalities. Nevertheless, the severer forms of sepsis, hospital gangrene, tetanus, pyæmia, and erysipelas, are no longer seen, as in former campaigns. The severest forms of sepsis are only seen in wounds infected from the intestinal tract, and a great deal of the suppuration actually seen is superficial and short-lived.

BURNS.

An injury from dry heat is called a "burn," one from moist heat a "scald." The former is produced by the flame of fire, gas, paraffin, and by explosions; also by electricity, X rays, and caustics. The latter by steam or boiling fluids.

Pathology.—General hyperæmia of internal organs.

Leucocytosis and destruction of red cells, the hæmoglobin from which lodges in the tubules of the kidneys.

Thrombi and extravasations in various tissues.

Degenerative changes in ganglion cells of the solar plexus.

Degenerative changes in lymphoid tissue.

Degenerative changes in the liver, kidneys, and spleen.

It would seem that the post-mortem appearances found are probably due to the action of a toxin.

Signs and Symptoms.—A burn is to be regarded as a wound, and treated accordingly. As in wounds of other kinds, there will be found differing amounts of injury in different parts of the wound; therefore the historic division of burns into "degrees" does not give a true clinical picture, but it is nevertheless a convenient classification so long as the student does not expect to see an entire burn of any one degree, unless, perhaps, it be the first.

Burns of the First Degree.—Erythema, from hyperæmia of local bloodvessels of the skin, commonly called a "scorch." There is acute pain from irritation of nerve-endings, heat, redness, swelling, and subsequent desquamation.

Burns of the Second Degree.—Vesication, with formation of a blister containing pyogenic organisms in the fluid. The sensitive papillæ of the skin are exposed under the raised epidermis. No scar, but discoloration, remains.

Burns of the Third Degree.—Partial destruction of the true skin. These are the most painful of all on account of the exposure and injury of nerve filaments. Granulation is rapid, and so is the formation of new epidermis. The resulting cicatrization causes no deformity.

Burns of the Fourth Degree.—Total destruction of the true skin. Pain is not severe, as the nerve endings have been destroyed, as well as all elements of the true skin; there is therefore much contraction in healing of the scar, in which keloid may develop. Septic infection is very liable to supervene in these burns, destroying the surrounding skin.

Burns of the Fifth Degree.—The muscles are reached and destroyed, producing a deep, muscular fibrosis on healing. Sepsis is common.

Burns of the Sixth Degree.—Charring of the bones or total destruction of the limb takes place. Septic infection is also common in this degree.

Prognosis.—A good deal depends on the position of the burn and the age of the patient. When a large, superficial surface is burned even slightly, the result is much more serious than in a small though deep burn, while a burn over the serous cavities has more serious consequences than one on the limbs. Burns of the neck and mouth owe much of their seriousness to the risk of œdema of the glottis. Children are likely to die from the initial shock, but that being tided over, will stand prolonged suppuration. After the shock, the great danger for all patients is sepsis.

Stages of a Burn.—These, under modern treatment, have been much modified, though they may still be looked upon as forming three periods.

First stage lasts for thirty-six to forty-eight hours, and is characterized by shock, which is severe in proportion to the amount of surface affected, the age of the patient, and position of the burn; that over the abdomen producing most shock.

Second stage is from the time the shock passes off till the separation of the sloughs, and usually lasts from one to two weeks. This period is marked by fever, the temperature rising at times to 104° F., while there is congestion of the internal organs, giving rise to complications, as bronchitis and broncho-pneumonia after burns of the throat, meningitis after burns of the head and neck, and gastro-intestinal inflammation after abdominal burns. These symptoms are much more aggravated when septic infection has taken place, and duodenal ulcer with perforation is sometimes then met with. The fact that inflammatory conditions of the internal organs have become less usual since burns have been recognized as wounds and treated on scientific principles seems to point to these complications being septic in origin.

Third stage begins with the separation of the sloughs, and ends with the healing of the wounds. During this time septic poisoning, waxy disease of the liver, kidney, etc., and duodenal perforation, may lead to a fatal termination. The duration of this period will vary with the extent of the burn.

Treatment.—Pain has to be relieved, septic poisoning prevented, and healing promoted. The one outstanding drug to achieve this is **picric acid.** The solution used may be made up as follows : Picric acid, 1½ drachms ; absolute alcohol, 3 ounces ; and water, 40 ounces.

It is often necessary to give an anæsthetic to cleanse the wound properly and remove all adherent cloth, etc., after which the surface of the wound should be gently washed with a mild antiseptic, and the picric acid applied on pads of sterilized gauze and covered with antiseptic wool. The dressing is changed about twice a week. On separation of the slough, the picric acid is stopped, and the dressing changed to that for an ordinary healthy sore. In the absence of picric acid boric acid powder thickly dusted over the part and covered with sterile gauze forms an efficient dressing.

Where the wound is very extensive or there is much suppuration, the burn is dressed with sterilized lint wrung out of hot boric lotion, or to immerse the part in a warm boric bath.

Skin-grafting is often needed to hasten healing and to correct subsequent deformity, after removal of scar tissue.

The *General Treatment* consists in combating shock and relieving severe pain with opium or morphia. The local treatment is commenced when shock has passed off.

INJURIES FROM LIGHTNING-STROKE AND OTHER FORMS OF ELECTRICITY.

The results of lightning-stroke are usually immediately fatal, or they are slight, the person struck recovering completely. Sometimes, however, the patient recovers with permanent disablement. The injury

is usually one to the nervous system ; thus, the patient may be blind or deaf, have various forms of paralysis or other nervous disease. The symptoms in most cases are similar to those of concussion of the brain.

It sometimes happens that the injury is similar to that produced by mechanical violence ; thus, a person may have fractured bones and contused or lacerated muscles, and the surgeon has sometimes to determine whether these injuries—it may be fatal ones—have been caused by personal violence or not. The old guide of arborescent markings on the body is not often present. When it is, it gives a valuable indication, as the marks are formed by the passage of the electric current.

The **post-mortem** appearances in those who have been killed or have died from the effects of lightning-stroke are—

Externally, marks of contusion or burning, or both, at the point of contact of the lightning with the body. The clothes covering the part are often torn and burnt. There may be a somewhat extensive ecchymosis on the skin of the back. Occasionally fracture of the skull or other bones is found.

Internally, it is usual to find congestion of the cerebral bloodvessels and those of the stomach. Most of the organs are found congested, especially the lungs, liver, and spleen. The heart, on the other hand, is almost empty of blood. It often happens in severe or fatal cases that a part or the whole of the brain is completely disorganized by the power of the current.

Accidents from the electric current used commercially will cause injuries which will be similar to those by lightning. There are, however, many minor accidents, which for the most part consist of burns, which, however, are often severe in their nature.

Treatment.—This is directed to combat shock. Burns and other injuries are treated on ordinary lines.

X-Ray Injuries.—No pain or shock is felt, and repeated and long exposures are necessary to produce bad effects.

There are two forms of injury—*i.e.* :

X-Ray Dermatitis, which corresponds to a burn of the first degree, but is much more chronic and difficult to treat. A red patch appears, which is painless, but itchy ; the skin becomes dry, cracks, and desquamates ; the nails become brittle, and tactile sensation is impaired. It is liable to recur on subsequent exposure to the influence of the rays.

X-Ray Ulceration.—There is redness of the skin and some pain. After a few days a blister rises, which contains sero-purulent fluid, underneath which is a painful red surface. A slough forms, which is very slow to separate, and the process is marked by severe pain. The slough may spread through to the muscles. Healing after separation of the slough is very slow. This condition corresponds to a burn of the fourth degree, but has its own special characteristics.

Treatment.—As for burns of the same degree. Artificial separation of the slough and skin-grafting are useful to hasten a cure.

GENERAL EFFECTS OF INJURY.

SHOCK.

Surgical shock is the name applied to a lowering of vitality due to trauma, and usually following close on it. It is immediately due to exhaustion or inhibition of the vasomotor centre in the medulla, owing to the number and severity of the afferent impulses reaching it from the site of injury; the more highly the injured part is endowed with nerves, the greater is the shock. Some authorities hold the view that shock is due to exhaustion and collapse due to inhibition of the centres. There is a marked fall in blood-pressure and dilatation of the veins, especially those in the splanchnic area. There are phenomena of circulation, respiration, and of the nervous system which would seem to be associated with the lowered blood-pressure, and may be the result of it or of other nerve-centres sharing the exhaustion of the vasomotor centre.

Predisposing Factors to shock are—*Old age*, in which there are few signs of shock, but little rallying power, the reverse is the case with children. *Sex:* Men are more susceptible than women. *Nervous temperament. Debility*, due to some existing disease, especially of the kidneys, heart, and bloodvessels, or malignant disease. *Time:* The hours before dawn are the most susceptible period.

Exciting Causes are loss of blood, great lowering of the body temperature, proximity of injury to the nerve centres, length of an operation and rough handling of parts during it, intense fear.

Signs and Symptoms.—The patient is prostrate, but can be roused to answer questions. The skin is pale and cold, while perspiration appears on the face and the rest of the body feels clammy. The features are shrunken. The pulse is rapid, fluttering, and of low tension. Respiration is hurried, sighing, and irregular. The mouth is parched. There is little sensibility to pain, and if an operation is undertaken during the period, little anæsthetic is required. The temperature may fall to 96° F., or even lower, owing to the dilated condition of the superficial vessels.

Reaction.—This occurs as a rule within a few hours, and is often indicated by vomiting. The pulse pressure rises slowly. Respiration and the pulse become slower and more steady. The temperature rises to normal or higher than normal.

Septic intoxication bears a close resemblance to shock, and has been mistaken for it. As a rule the association of shock with injury is much more immediate than is that of septic poisoning with injury.

Operations and Shock.—*Unless imperatively demanded, no surgical operation should be performed during the period of shock.* To prevent shock in serious surgical procedures, the patient should have a few days' rest in bed and a good night's sleep prior to the operation. Some surgeons inject ½ grain of morphia a short time previous to operation; others introduce a pint of saline into the rectum before and after the operation. The operating theatre and all lotions used should be warm, and the body covered where not required for the purposes of the operation. Exposed viscera should be covered with warm moist gauze or towels, and as little hæmorrhage as possible permitted. As prompt an operation as is consistent with efficiency is to be aimed at.

What is called **blocking the nerve trunks** (Crile) to prevent shock is achieved by injection into them of 2 grains of eucaine or 5 grains of novocain on the proximal side of the field of operation. Spinal anæsthesia does not lower the blood-pressure, and so prevents shock at the time, but there is subsequent shock when the effects pass off. General anæsthesia diminishes the capacity of the centres for the receipt of stimuli, but lowers the blood-pressure and nerve vitality. Thus, it is a wise rule to have a full degree of anæsthesia for skin incisions and handling of viscera, and a less degree at other times.

Treatment of Shock.—As there is anæmia of the brain, the patient should be placed in the recumbent position with the feet raised. Heat by means of a fire in the room, cotton-wool, blankets, and hot bottles, should be procured. After serious hæmorrhage, the limbs should be encased in cotton-wool, and bandaged firmly from below upwards. One pint of saline solution, with 10 minims of adrenalin chloride (1 in 1,000) should be given by the rectum, and the injection repeated in about two hours, and kept up till the circulation has improved. The saline solution had better be introduced into a vein, or the subcutaneous tissue, when there has been great loss of blood. The temperature of the solution should be about 105° F.

COLLAPSE.

This term signifies a condition which, closely resembling shock, may also succeed it. It comes on more slowly, and is the result, not of exhaustion of nerve centres, but of slow **toxic** injury, as intestinal obstruction or peritonitis, and, perhaps, more markedly seen in conditions which are associated with a withdrawal of large amounts of fluid from the tissues and the blood, as in diarrhœa, following the profuse sweating of heat stroke, and after severe hæmorrhage. It should be remembered that collapse may be met with following shock after abdominal operations where peritonitis is present, especially where there is vomiting, as in high obstruction of the intestines.

The symptoms and treatment are similar to those described under Shock.

SYNCOPE.

This condition is the result of a sudden anæmia of the brain, and is produced by reflex inhibition of the cardiac and respiratory centres with a weakening or temporary arrest of the action of the heart.

The **Causes** of the condition are various. It may be due to fear or grief. To the sudden assumption of the erect position by anæmic persons. In surgical practice it is met with in nervous persons who have to undergo pain, as in the reduction of a dislocation or during the incision of an abscess, etc. The condition often follows the **quick** withdrawal of fluid from the abdominal and pleural cavities ; hence the need for doing these operations with care, and allowing only a gradual flow of fluid in tapping for ascites or pleurisy. During **operations** it may occur in dragging upon viscera, dilatation of the sphincter ani, and when the procedure is near the superior laryngeal nerves. When syncope occurs during an operation under anæsthesia, it is, as a rule, owing to its being incomplete, and thus if the centres become inhibited by the stimulus of the operation.

A valuable indication of the onset of the condition during operation is the stopping of oozing from divided vessels.

Symptoms.—The patient feels giddy and sick, has singing in the ears, and dimness of vision. The pupils become dilated, and the pulse small and of low pressure. The respiration is hurried or shallow. Consciousness goes, and the patient suddenly falls. If actual vomiting occur, the attack may be warded off. The clinical picture resembles shock, but it is much more sudden in its onset.

Treatment.—This is simple as compared with shock, since there is no exhaustion, but merely inhibition or anæmia of nerve centres.

The head should be lowered and tight clothing removed. To stimulate the heart cold should be applied to the face and chest, and volatile substances to the nostril. If these measures do not restore consciousness, strychnine or ether should be injected, and hot cloths applied to the heart and the faradic current over the phrenic nerve above the clavicle.

Traumatic Delirium.

Delirium is a disturbance of the mind lasting for a longer or shorter period, and indicating a serious condition. It occurs in many diseases ; surgically, it is due to two causes : (*a*) Severe injury or operation in nervous subjects, and (*b*) intemperance. To the former the name of **traumatic delirium** is given ; to the latter, **traumatic delirium tremens.**

Traumatic Delirium.—Is specially likely to follow operative procedure or injury to the genito-urinary organs, neck, and face.

The **Symptoms** appear about four days after the trauma. The patient is restless, mutters below his breath, picks at the bedclothes, and does not sleep. There may be fever, and tremor of the muscles. The patient may become hysterical, melancholic, or insane.

Treatment.—Sleep should be procured by the administration of bromides, and the patient's strength supported by nourishing fluid food.

Delirium Tremens.—When drunkards, or habitual drinkers of large quantities of alcohol, are obliged to lie in bed for a time owing to an accident, delirium often manifests itself, and usually within a few days.

Symptoms.—The patient refuses food, is sulky and suspicious, and wishes to get out of bed. There is well-marked tremor of tongue, lips, and hands. The usual fancies concerning vermin and creeping things are present. The pulse is of low tension, the temperature is slightly raised. Gastro-intestinal symptoms are present. The patient is insensible to pain. The condition under treatment will usually clear up in a few days, but in some cases delirium becomes more pronounced, and the patient dies from exhaustion.

Treatment.—The patient must be carefully watched by an attendant, lest he get out of bed and do himself harm. Bromides in full doses should be given frequently to produce sleep, and seldom fail ; if they do, sulphonal or chloral can be tried ; morphia and hyoscin may be used if everything else fails, but must be given with the utmost caution. Fluid nourishing food should be administered frequently, by artificial means, if necessary.

Fat Embolism.

After injuries and operations involving the marrow of long bones, fluid fat may enter the blood ; and if the quantity be large or absorption long-continued, symptoms referable to the lungs or brain may ensue.

In the **Lungs** the fat collects in the small bloodvessels, and produces congestion and œdema, sometimes pneumonia. The symptoms are dyspnœa and cyanosis, a cough with blood-stained sputum, feeble pulse, and subnormal temperature. Hæmaturia commonly present.

In the **Brain,** where the fat lodges in the capillaries, the condition is usually rapidly fatal, producing symptoms of delirium followed by coma and accompanied by a small, rapid, and irregular pulse. Fat may usually be detected in the urine.

The **Treatment** is to tide over the acute stage of the illness, treating symptoms as they arise, and giving time for the elimination of the fat from the blood.

Traumatic Asphyxia.

This is a condition produced by the violent compression of the thorax so that respiration is arrested for a brief period. It occurs when a person is severely crushed, and is accompanied by cyanosis, which is produced by stasis from overdistension of the veins and capillaries. Shock is present, and should be treated. The cyanosis usually disappears in a few days.

CHAPTER XI

INJURIES AND DISEASES OF MUSCLES, TENDONS, AND BURSÆ

Contusion—Strain—Rupture. Myositis: Traumatic, suppurative, tuberculous, syphilitic, ossificans. Tumours—Atrophy—Rheumatism—Lumbago—Stiff neck—Neuralgia—Contractions.

Sheaths and tendons—Displacements—Rupture—Wounds—Teno-synovitis—Ganglion—Tendinitis—Compound palmar ganglion. Bursæ—Bursitis: Traumatic, trade, infective, malignant.

INJURIES AND DISEASES OF MUSCLES

Injuries of muscle comprise not only direct harm done by some form of violence to the muscle-fibre or tendon, but also those special diseases or forms of disease which are of traumatic origin.

When an injured person presents himself for examination, even if special damage to muscle is not anticipated, care should be taken that such is not overlooked, being perhaps overshadowed by some more serious condition of the parts. If, however, the history and symptoms point to a muscular lesion, then special care should be devoted to its nature and possible results. Perhaps from the very simplicity of the case, so far as its pathology is concerned, such a condition as ruptured muscle-fibres does not trouble us much as to diagnosis or prognosis, and the case is dismissed with an order for spirit lotion to be applied, and only when the patient returns to report loss of function of the part is it realized that a more serious matter than was thought has to be dealt with.

The muscle should be examined to ascertain if there be any swelling or gap in its substance or at the junction of tendinous and fleshy parts, and whether the tendons have their normal relationship to the bones.

Signs and Symptoms.—The general signs and symptoms of injury to muscle are—Swelling and tenderness, loss of power, with acute pain on trying to put into action the particular muscle injured. When a gap can be felt in addition to the swelling, rupture of several fibres, perhaps of the entire fleshy belly, is indicated; any attempt to use the muscle makes the gap more evident.

When a tendon is **ruptured,** there is no gap in the body of the muscle, and it may be impossible to discover any in the tendon itself, unless in the case of a large and complete break; but it is found impossible to contract the parts served by the muscle or to make its tendon tense.

In **dislocation** of a tendon there is acute pain on attempting to use the muscle, but it can make the tendon tense and move the part served. It may be possible to determine that the tendon does not occupy its normal position, but, on account of the swelling and the pain of examination, this is often difficult.

It is sometimes found after an injury that there is complete loss of function of several muscles, but no local abnormal condition can be detected; it may then be concluded that the nerve supplying the part has been severed or severely contused, and this can be verified by noting that the muscles implicated correspond to those supplied by a particular nerve.

With regard to regeneration of muscle after injury, it is a remarkable fact that while hypertrophy occurs in both health and disease, with an increase of the bulk of fibres and also in their numbers, yet after injury to voluntary or to heart muscle, involving destruction of a part of the muscle fibres, regeneration does not take place, the injured muscle being replaced by connective tissue, and a scar results.

INJURIES TO MUSCLE.

Contusions.—When muscles are bruised by a fall or blow, there is some extravasation, with possible rupture of fibres. There is local tenderness, swelling, and pain. If the individual be healthy, local treatment and rest will put the part right, and there will be no bad consequences. If, however, there be predisposition to constitutional disease or a very much lowered vitality, there may be formation of pus and a prolonged period of convalescence.

Muscle Strain.—This is frequently brought about by a violent effort or by attempting to recover balance after equilibrium is lost, and usually results in stretching or even tearing of some fibres. What has been said about prognosis in contusions applies also to strains.

Rupture of Sheath.—An occasional accident caused by violence, in which the fleshy belly of the muscle protrudes through the opening in the sheath, and may be recognized as a soft, almost fluctuating tumour. Healing may be long delayed, especially in those cases in which a wrong diagnosis had led to unwise initial treatment. In such cases it may be necessary to cut down and suture the sheath. The muscles most often affected are the biceps cubiti and the rectus femoris.

Rupture of Muscle.—This occurs as the result of a sudden or unexpected violence, and the entire fleshy belly may be severed, or only some of its fibres.

Signs.—The person feels a sharp pain, and may feel a distinct snap. There is loss of function and local swelling, while a gap may often be felt, especially when an effort is made to contract the muscle. Some period elapses before the muscle is again in a condition to be used, as the union is often weak, being formed of slowly organized cicatrization of the granulation tissue, which results from the vascularization of the plastic effusion poured out at the time of the injury.

This accident is sometimes attributed to a sudden sharp blow, as in a case where the injury was caused by a blow from a tennis racket on the leg; there was loss of function of the injured muscle, considerable pain and stiffness, and a distinct gap; the history here given was that while the player was in the act of stretching up to return a ball his partner hit his leg, the muscles of which were tense, and the player felt a sudden pain and snap. It is quite possible that the accident so occurred, being caused by the sharp stroke on a stretched muscle. It is more likely, however, that the rupture was caused by a sudden over-tension of the muscle fibres in the act of playing.

It sometimes happens that after rupture of the fibres of a deeply situated muscle the formation of pus occurs, and a deep-seated abscess results.

If the skin be not broken, it is probable that such formation is the manifestation of the tuberculous diathesis, though this is sometimes difficult to prove. In one such case a constable on duty had given the muscles of his thigh a sudden strain; he felt a snap and pain, but paid little attention to the matter for some time, when increasing pain and inability to do his work led him to seek advice. After some palliative treatment he was admitted to hospital and operated on; the skin was incised, and a careful exploration of the part carried out; on pushing a director some distance between the muscles, pus was liberated, and further investigation revealed a large abscess cavity. This man was a healthy subject, and had no rise of temperature. In view of possible consequences such as this, the prognosis in a case of ruptured muscle should be guarded, since after abscess formation some contractile tissue is destroyed and deformity may result.

Traumatic Myositis.—This is an inflammation of muscle caused by contusion or laceration. It is usually recovered from without any bad consequences, but occasionally it becomes chronic, leading to *myositis fibrosa*, a condition in which the muscular substance becomes shortened and is replaced by fibrous tissue. In other cases chronic irritation of muscle or tendon leads to ossification; such is the so-called "rider's bone," which is an ossification of a portion of the adductor tendon.

Acute Suppuration Myositis.—In this condition, as the result of infection with pyogenic organism from without through a wound, there is a formation of pus which spreads widely, and usually produces great cicatricial deformity. There are other forms not due to injury.

Chronic Tuberculous Myositis.—This condition may be started by an injury to a muscle in a tuberculous subject or spread from an injured bone or joint.

Syphilitic Myositis.—This manifestation of the disease may take the form of diffuse sclerosis or localized gumma; if the latter, an injury may be the exciting cause. Care should be exercised not to confuse this condition with tumour formation; this is best avoided by attention to the specific history—the slow growth and hardness, with subsequent softening of the gumma, and also by the effect of antispecific treatment.

Myositis Ossificans.—When traumatic in origin, it may be met with in the crureus or vastus externus as the result of a kick from a horse; in the brachialis anticus, following dislocation of the elbow; in the adductor longus, from excessive horseback exercise—"rider's bone"; in the deltoid and pectoral muscles, as the result of recoil from a rifle—"drill bone."

It is possible that, as a result of accident, a portion of periosteum is detached and becomes embedded in muscle, and so gives rise to the bony tumour.

If causing inconvenience, the tumour should be removed.

Tumours of Muscle.—These are not common; when present, they are angioma, fibroma, chondroma, myoma, or sarcoma. Some of these forms may have their origin in injury, and this should be remembered as a possible consequence to accidents involving muscular tissue.

Treatment of Muscle Injuries.

Contusion.—The muscle should be placed at rest, and the injured part covered with a thick layer of cotton-wool and a bandage. Later on massage, electricity, and passive movements, will facilitate restoration of function.

When the muscle is **strained** or some of the fibres ruptured, there should be rest, especially from particular efforts that have produced the condition, as in "miner's back" and "tennis elbow," and later on massage should be carried out.

In **Rupture of the Sheath** no treatment is needed unless the condition gives rise to inconvenience, when an incision should be made over the injured part, the protruding portion of muscle returned to its sheath or removed, and the tear in the sheath sutured.

When a muscle is completely **ruptured,** the ends should be accurately united by catgut within a week; old injuries do not unite well, owing to retraction and adhesions to surrounding tissues.

When trauma sets up **disease** of muscle, the treatment will be that of the disease.

DISEASES OF MUSCLES.

There is sometimes a **congenital** absence of a muscle, which is usually associated with some other congenital deformity.

Atrophy of muscle may be due to (*a*) non-use; (*b*) disease of joints, when it arises from non-use and interference with trophic innervation from the centres; (*c*) **neuropathy,** arising from some lesion of the nervous system, when the structure of the muscle is altered by fatty degeneration; then absorption takes place, and finally the muscle fibres are replaced by connective tissue and fat. The muscles show the reaction of degeneration.

Muscular "Rheumatism."—A little understood affection, chiefly of the fibrous tissue of muscles. Lumbago, stiff neck, and intercostal neuralgia (or pleurodynia), are the chief examples.

Lumbago.—There is pain over the sacrum and the lumbar muscles. When the patient attempts to move, the pain is of a most intense character, which paralyzes movement. It is most marked on assuming the erect position after stooping, and may shoot down the thigh, probably owing to the coexistence of sciatica. It is apt to recur, the recurrence seeming to be associated with exposure to cold, unusual exertions, or errors of diet. Lumbago is most usually met with in the gouty or rheumatic subject.

Stiff Neck.—Sometimes called "rheumatic torticollis"; is a one-sided affection of the neck. There is a voluntary contraction of the sterno-mastoid muscle, and considerable pain and tenderness, which at times is marked over the spines of the vertebræ.

Intercostal "Neuralgia."—There is pain and tenderness along the line of one or more intercostal nerves, which is increased on deep inspiration, coughing, etc.

Treatment for these conditions is directed towards regulation of diet, and the correcting of gouty and rheumatic tendencies. Of drugs, the best are aspirin for relief of pain, followed by full doses of iodide of potash; occasionally hypodermic injections of morphia are called for. Later, massage and muscular exercises will tend to prevent return of the ailment.

Contraction of Muscles.—Shortening of muscles may arise from prolonged flexion, or from changes in their substance produced by disease or injury. It accompanies, and may cause, certain deformities, and requires lengthening of muscle or tendon for its correction.

Ischæmic Contraction (Volkmann's Paralysis).—See Deformities of Upper Limb (Chapter XIV.).

Myositis (Inflammation and Degeneration of Muscles).—Various inflammations are met with, apart from the simple, transitory inflammation produced by slight injury.

Pyogenic.—Present in pyæmia and typhoid. There may be overgrowth of connective tissue and degeneration of fibres, or abscess formation in the substance of the muscle may occur.

Gonorrhœal.—Occurs in late stages, is very painful, but rarely suppurative.

Syphilitic.—A dull, aching, nocturnal pain occurs in the muscles, especially of the neck and back, during the secondary period of the disease. (For **syphilitic contraction,** see Deformities.)

Tuberculous.—May be due to direct infection or secondary to disease of other structures. Nodules may be found in the muscles.

Myositis Ossificans.—When this is a progressive ossification of the muscular tissue of the body, the disease usually attacks the muscles of the back first, and leads to extensive ankylosis. A point to be remembered in diagnosis is that the disease is usually accompanied by congenital deformity of the great toes, the proximal phalanx being absent or undeveloped.

On examining the affected area, swellings are found in the muscles, which may disappear or form the site of the ossification. They are sharply defined and elastic, but without tenderness.

Pathology.—There is first a proliferation of the intramuscular connective tissue, then a deposition of lime-salts, and gradually a replacement of the muscular fibres. Great deformity results from the disease. It generally attacks young males, proceeds spasmodically, and is incurable. Death usually takes place in about ten years.

Ossification in muscles and tendons also takes place as the result of injury, as already pointed out, and also in connective tissue in the course of **arthritis deformans** and **Charcot's disease,** and when occurring in connection with bone is referred to as **false exostosis.**

Tumours of Muscles.—Innocent tumours are very rare. Malignant tumours are met with in the muscles as primary growths, or secondary to growths in adjacent tissues. The tumours spring from the connective tissue, not from the muscle fibre.

Recurrent Fibroid of Paget is a fibro-sarcoma chiefly of the muscles of the abdomen, though met with elsewhere. There also occurs an ossifying chondro-sarcoma.

Treatment.—The tumour should be removed with the muscle if it be a primary growth. The function of a limb may be retained by transplantation on an adjoining muscle.

INJURIES AND DISEASES OF SHEATHS AND TENDONS

INJURIES OF SHEATHS AND TENDONS.

Displacement of Tendons.—During some violent exercise, especially with a twisting movement, tendons are sometimes displaced from their osseo-fibrous canals. When this occurs, there is sudden pain, followed by limitation of mobility. The tendon may be felt in an abnormal position in the more superficial situations. If moved, the abnormality of position becomes more evident. The tendons about the wrist and ankle are those most frequently dislocated, and next to these the tendon of the biceps from its groove in the humerus.

The prognosis in this accident is good if the case be carefully treated, but if movement is allowed too soon the dislocation will recur, and the tendon may thus acquire the "habit." A considerable time of rest is required. In some cases a permanent weakness results from the accident.

Rupture of Tendons.—This may occur at the point of juncture of tendon to muscle or of tendon to bone; the former is the more common.

The **Signs** of the accident are somewhat similar to those of rupture of muscular tissue except that the gap is not so evident, and on contracting, the muscle rises as one protrusion not as two.

If the attachment of the tendon to the bone be severed, operative procedure may be necessary to again attach it.

Most severed tendons will reunite firmly if a sufficient amount of relaxation can be secured, though sometimes artificial means may be necessary to effect or hasten a cure.

Great pain may at times be caused by dragging on the sheath of the tendon after rupture.

As a rule the new tendon substance is quite as strong as the old, and no permanent disability results unless the gap is wide, owing to insufficient relaxation being secured in treating the injury. If there be loss of tendon substance, grafting or splitting of the tendon will be required to effect a sound cure.

Wounds.—The wrist tendons are particularly liable to be severed by accident; for example, by thrusting the hand through a window. The ends should be sutured at once.

Drop or Mallet Finger.—See Deformities, Chapter XIV.

Teno-Synovitis.—This is an inflammation of the membrane lining the sheaths of tendons, and is set up as a rule by injury, though some forms, due to constitutional disease, appear apparently without such exciting cause.

Simple inflammation follows sprains, and is often seen in connection with the extensor tendons of the thumb. A swelling in their course is produced which is tender to touch. Any movement of the affected muscles is accompanied with marked pain, and gives a characteristic crepitus at the part affected.

If this condition be not treated by rest, and later with friction of the part, a chronic state may be induced in which there is little pain or tenderness, but weakness of the part and a creaking on movement of the tendons, which can be felt and heard. This weakness may

incapacitate from heavy muscular employment almost definitely, as, once set up, it is a most difficult condition to cure.

One type of **tuberculous teno-synovitis** closely resembles the ordinary chronic variety, and the one may possibly drift into the other, the injury, as elsewhere, being the exciting agent. There is no creaking of tendons, however, and more pain on movement. Along the line of the tendon sheath is an elastic swelling ; this is formed by granulation tissue containing tubercle bacilli. If suppuration take place, the neighbouring bony structures become involved. The other type of tuberculous disease of tendons may be distinguished from the ordinary chronic inflammation by the presence of **melon-seed bodies,** which are masses of fibrin containing tubercle bacilli.

If the injury to the tendons be of such a nature that septic poisoning results, as in punctured wounds of the sheath, suppuration will be set up, which often spreads to the surrounding tissues. This condition, if not treated energetically, may lead to very serious consequences, resulting in loss of function of muscles and involvement of joints.

The ordinary **whitlow** is a common example of a minor form of suppurative teno-synovitis.

Treatment.—Lead and opium fomentations or belladonna and glycerine should be applied to relieve pain, and a splint, in the case of injury to the thumb tendons, to give rest to the forearm as well as the hand.

Bier's hyperæmic treatment has been found useful.

When suppuration has taken place, hyperæmic treatment should be adopted, and incisions made at the points of greatest pressure, for the liberation of pus. Later, movement should be adopted to prevent adhesions forming between tendon and sheath. If there is any portion of the tendon which sloughs, it should be cut away.

Ganglion.—The simple ganglion is sometimes the result of a localized chronic teno-synovitis or of a protrusion of the synovial membrane through an opening in the tendon sheath. It may thus be due to injury, though often occurring independently.

DISEASES OF SHEATHS AND TENDONS.

Tendinitis.—This is caused by strain of tendons in gouty and rheumatic subjects, and is met with especially in the tendo Achillis.

Symptoms.—Pain, which is aggravated by exercise. Tenderness and swelling over the site of the tendon, while nodules of gouty origin may be found in its substance.

Treatment.—Constitutional treatment combined with massage, while the tendon is fixed in a relaxed position by means of adhesive plaster or splints.

Teno-Synovitis—(*a*) **Gouty.**—By deposit of urates under the endothelial lining of tendons or sheaths, nodular swellings are caused, which move with the tendon. These may occasion interference with the proper function of the tendons, when they should be removed, while in all cases constitutional treatment should be adopted.

(*b*) **Gonorrhœal.**—This occurs as a painful œdema, or, where serous effusion has taken place into the sheath, as a fluctuating swelling during

the latter period of gonorrhœa. It may be associated with affection of the joint. Occasionally the infection is attended by formation of pus.

The tendons of the wrist and ankle are chiefly affected.

Treatment.—This consists of rest and the application of a soothing lotion for the milder forms, while for the more severe hyperæmia should be induced; serum and vaccine treatment give good results in some cases.

(*c*) **Syphilitic.**—The infection during the second period of the disease consists of effusion into the sheaths; during the tertiary period, of formation of gummata.

Treatment.—Local symptomatic treatment should be adopted, with the constitutional treatment suitable for the period (see Syphilis).

(*d*) **Tuberculous.**—**Compound Palmar Ganglion** is an altogether different affection to simple ganglion, being tuberculous in origin, and involving the flexor tendons of the wrist. The cavity formed is distended with synovia containing *melon-seed bodies*, and forms a large swelling, usually extending above and below the wrist, and bound down in the middle by the annular ligament. Overgrowth of the fatty fringes of the synovial sheath sometimes takes place; this condition is termed "arborescent lipoma."

It is not certain whether this condition arises altogether independently of injury in a tuberculous subject, or whether it may be excited by a previous accident to the part. Taking into account the part played by injury in lighting up tuberculous disease in various parts of the body, it seems reasonable to suppose that here also it bears a part.

The condition is of very slow growth, but is aggravated by strain of the tendons involved. Occasionally a sinus is formed by the breaking down of the skin over the swelling, probably due to its becoming infected with the disease. Tuberculous disease of tendon sheaths may, of course, be met with in other situations than the wrist.

Treatment.—The contents are removed by a subcutaneous incision and the cavity injected with iodoform glycerine. Should this fail, an open incision is made, the contents of the cavity removed, and the wall scraped, after which the wound is closed. Care should be taken to avoid adhesions by making early movements.

Those forms of teno-synovitis which are of traumatic and septic origin have been referred to already.

Ganglion.—This shows itself as a cyst-like elastic swelling in connection with a tendon sheath, and contains a clear gelatinous substance. It is most commonly situated on the back of the wrist, but is also met with on the front of the wrist, on the dorsum of the foot, at the knee over the interval between the femur and tibia at the outer aspect of the joint, and in front of the biceps tendon.

As the cyst grows larger it becomes painful, and induces weakness of the part.

There is a difference of opinion as to whether a ganglion is a direct result of a protrusion of synovial membrane, a protrusion which has become separated, or a new formation resulting from colloid degeneration of the fibrous tissue of the capsular ligament.

Treatment.—Puncture with a tenotomy knife, the removal of the contents of the ganglion, and subsequent pressure, may produce a cure. The injection of 5 minims of the following mixture: alcohol 10 per cent., camphor 4 per cent., and carbolic acid 4 per cent., after removal of the contents of the ganglion, gives good results. Some

surgeons prefer to secure counter-irritation by scraping the inner wall of the ganglion. It may also be dissected out through an open incision.

Tumours.—Certain tumours are met with in tendon sheaths, as fibroma, lipoma, and myxoma, but they are extremely rare. Sarcomata are more common, as is also myeloma, which occurs at the wrist or ankle, and forms a long-shaped swelling composed of giant cells. It should be dissected away, and seldom returns. The removal of sarcomata will probably necessitate the removal of the tendons, if not of the limb.

INJURIES AND DISEASES OF BURSÆ

INJURIES TO BURSÆ.

Bursæ exist in the body to avoid pressure on certain bony structures more exposed than others. In certain cases, owing to occupation, etc., adventitious bursæ are developed over prominent structures.

A bursa is a closed sac lined with synovial membrane, and containing a small amount of fluid. Various injuries cause changes in the sac and its contained fluid, these may occur in normal or adventitious bursæ.

Bursitis.—The inflammation may be simple, as in a blow or fall on the bursa, or from prolonged irritation or slight trauma; the latter cause is met with specially in rheumatic or gouty subjects.

There is pain, swelling, tenderness, and some heat. Effusion into the cavity takes place, and is often mixed with blood. Adhesions may be set up by the deposition of lymph on the serous surface, complete obliteration of the cavity in some cases taking place.

Chronic Bursitis may supervene if proper treatment be not adopted and persevered with, or may arise from repeated attacks of the acute variety in those predisposed thereto. In some cases the condition is chronic from the commencement, and is then usually due to a constitutional diathesis, and develops from within.

One form of chronic bursitis is known as **fibroid disease of bursæ.** In this the walls of the bursa are thickened by prolonged irritation or the effects of syphilis. There is little effusion in this variety, a hard tumour with a very small central cavity taking the place of the bursa.

There is a distinct **tuberculous bursitis** which may be secondary to joint affection or give rise to it. It may follow injury to a bursa, and this possibility should not be lost sight of in dealing with bursitis resulting from injury in tuberculous subjects. The tuberculosis manifests itself by deposit of fibrin on the inner walls, accompanied by effusion and the presence of **melon-seed bodies**, or by pulpy degeneration of the joint, with a late formation of a chronic tuberculous abscess.

Acute Suppurative Bursitis is due to septic changes following a penetrating wound. It may also occur from infection of the joint from within. There is constitutional disturbance indicated by rise of temperature and increased pulse-rate, and other symptoms associated with the formation of pus. Locally there is heat and tenderness, and usually swelling of the part; occasionally, however, the pus travels through a burst capsule, and appears at a different point, thus disguising its origin, and enabling the examiner to feel the bone without the intervention of an abscess cavity. The underlying bones and joints become affected, leading to necrosis and acute arthritis. The prognosis is usually favourable if prompt measures are taken, though destruction of the bursal cavity may lead to some disability of the part for a time at least.

The special bursæ to be remembered are—

The **Bursa Patella,** which, on account of its exposed position, is very liable to injury, especially in those who have to kneel much; hence the term "housemaid's knee."

The **Bursa of the Ligamentum Patellæ** is situated between it and the head of the tibia, and when enlarged appears as a swelling on either

side of the tendon; the *ligamenta alaria* may be pushed back and nipped between the bones of the joint whenever the patient stands with leg extended, the pain simulating a displaced semilunar cartilage.

The **Bursæ of the Popliteal Space** are not very often enlarged by injury, but for purposes of diagnosis it is well to remember there is a fluctuating swelling formed which, on account of the closeness of the large popliteal vessels, has a pulsation of a heaving character.

Of the popliteal bursæ, the one which is most frequently enlarged is that between the semimembranosus and the inner head of the gastrocnemius. It forms a fluctuating, oblong tumour at the inner side of the popliteal space, and becomes tense on extension of the leg. If causing inconvenience, it may be dissected away. There is often a **communication with the knee-joint,** which should be sutured if the bursa is removed.

The **Bursa of the Tendo Achillis** is sometimes injured. It is recognized as a fluctuating swelling on either side of the tendon, and confined to the posterior part of the ankle-joint, thus distinguishing it from disease of that articulation.

The **Bursa of the Psoas Tendon** may be injured, and, when distended, projects at the inner side of Scarpa's triangle; it must be distinguished from disease of the hip-joint and psoas abscess, which it simulates, since the thigh is bent to relieve pain. This bursa is also liable to tuberculous disease.

The Gluteal Bursæ. The bursæ situated between the gluteus maximus and the great trochanter are not injured directly, but may be by indirect violence. They are also frequently the seat of tuberculous disease, spreading from the trochanter, which is difficult to distinguish. The disease may be started by injury. When enlarged, a rounded swelling obliterates the hollow behind the great trochanter, and may lead to abduction and eversion of the limb in order to relax the muscle.

The **Bursæ over the Tuber Ischii** may be injured by constant excessive pressure, as in "weaver's bottom," or by accident. The condition is easy of diagnosis.

The Bursa over the Olecranon. Enlargement of this constitutes student's or miner's elbow. In these occupations it is due to excessive pressure constantly applied, but enlargement may also occur as the result of accident. Suppuration from an infected bursa may lead to necrosis of the olecranon; the elbow-joint usually escapes.

The **Subdeltoid Bursa** is sometimes injured indirectly, and when it is, produces the signs of prominence of the muscle and broadening of the shoulder, it has to be diagnosed from effusion into the shoulder-joint; in the case of an enlarged bursal sac, there is no axillary swelling, nor any on the anterior and posterior borders of the deltoid, while passive movements do not produce pain when the head of the bone is pressed into the glenoid cavity, as they do in effusion.

Other bursæ less frequently affected are—

The **Subscapularis,** situated under the tendon of the muscle. It causes interference with normal movements.

The Radial Tendon of the Biceps. When the bursa under this tendon is injured, it causes pain and swelling about ½ inch below the bend of the elbow, and interference with the movement of flexion and supination, and restriction of those of extension and pronation.

Subcalcanean. When this bursa is affected it gives rise to pain and tenderness on the sole of the foot, and may be associated with a bony outgrowth of the os calcis. Bursa and outgrowths should be removed.

There are many adventitious bursæ formed over projecting bone in deformities, which are liable to be injured and to become enlarged or inflamed.

The general **Treatment** of traumatic bursitis differs with the stage. When the case is acute, it requires rest, and fomentations, and firm pressure. The fluid can be got rid of by blistering, tapping, or by drainage after incision. When the case is chronic and the wall of the bursa thickened, excision will probably prove the most satisfactory treatment, though, where applicable, a plaster of Paris bandage may be effective. In septic conditions the treatment will follow general principles.

DISEASES OF BURSÆ.

Though trauma, either single or multiple, and perhaps more especially that form of trauma which consists of a constant irritation or pressure, is responsible for most of the conditions found in bursæ, yet disease has its place, either as a factor with trauma, or independently thereof, in producing abnormalities of bursæ.

Trade Bursitis.—This is traumatic, inasmuch as it is due to continued pressure on some bursa ; but, taking into consideration the number of housemaids who never develop " housemaid's knee," the number of miners who never develop " miner's elbow," and the few tailors who develop " tailor's bottom," we must look for some other cause, which is probably found in some toxic condition of the blood, leading to occupation bursitis in certain individuals.

Taking enlargement of the prepatellar bursa (" housemaid's knee ") as a type, we find in acute cases a hot, tender enlargement in which fluctuation can be detected over the bone, thus differing from **synovitis,** in which the bone is found riding on top of the fluid. For such a condition the treatment is rest and fomentation. In the more common chronic affection there is a **gradual** accumulation of fluid referred to as **hydrops** or **hygroma,** and after repeated attacks the wall of the bursa becomes thickened by fibrous tissue, which may be so arranged as to form fringes somewhat resembling those found in arthritis deformans. Part of the fringe may break away to form loose bodies. If the thickening be uniform, a fibrous tumour—**solid bursal tumour**—with a small central cavity will result. For the chronic condition with thickened walls, the best treatment is excision ; short of this, and for the less chronic type, equal continued pressure by means of plaster of Paris bandages, or adhesive strapping, may be tried.

Gonorrhœal Bursitis.—Occurs either separately or as a part of a joint affection.

Syphilitic Bursitis.—Occurs as a gummatous affection, usually in connection with the bursæ in front of the knee, rarely as a serous affection during the secondary period.

Rheumatic Bursitis.—Especially in the rheumatism following scarlet fever. A very persistent type.

Gouty Bursitis.—Urate of soda is deposited in the sac, and a chalky tumour of considerable size may result, or inflammation of the skin and discharge of chalk stones may take place. Common over the olecranon process and great toe.

Tuberculous Bursitis.—Most common in the **gluteal, psoas, subdeltoid,** and **prepatellar** bursæ. It may be primary or secondary to disease of the joint.

It occurs as a slow-growing hydrops, usually leading to chronic suppuration.

If possible, the affected bursa should be excised, or, where this is not practicable, it should be incised, scraped, and treated by the open method.

Septic Bursitis.—Apart from traumatic origin, this may result by extension from a suppurating joint, etc., but it usually results from an infected wound of the bursa or of the neighbouring skin.

There is redness and swelling ; if untreated, it spreads through the wall of the bursa, or down the limb in the cellular tissue.

The treatment is to make an early incision and drain the bursa.

Malignant Bursitis.—Occasionally sarcoma of a bursa takes place, giving rise to a nodular, rapidly growing tumour. Early excision or amputation of the limb is required.

CHAPTER XII

INJURIES AND DISEASES OF BONE

Injuries: Contusions, wounds, fractures in general, separation of epiphyses, special fractures—Diseases: Traumatic inflammations, periostitis, osteomyelitis, tuberculous disease, syphilitic disease—New growths.

INJURIES TO BONE

THE whole question of injury to bone is one of great importance. The results of injury to no other structure are probably so difficult to prognosticate, nor is any other so liable to accident of a serious nature, which will necessitate such a prolonged period of disability. In the case of fracture loss of continuity in the bony framework renders the remaining tissues of a limb *hors de combat* so far as earning a living by muscular labour is concerned. It is, however, not to fracture of bone alone, nor indeed chiefly, that the subject owes its importance, but rather to the number of bone troubles that are commonly classed as diseases, but which in reality are due largely to injury in the first place, though after developments are due to the action of micro-organisms.

The patient suffering from some constitutional weakness or disease figures largely among those suffering from injury to bone. No contrast can be greater, or indicate more clearly the need for separate classification of workpeople, for medico-legal purposes, than the case of the tuberculous youth who on the slightest provocation develops bone trouble, and the healthy one who can have his bony tissue maltreated almost with impunity so long as the force used is not sufficient to cause fracture. Nor is it only in the case of some specific disease that serious results may arise from bone injury. In those who are run down in health, whose opsonic index is below par, such a simple injury as a contusion may give rise to acute infective periostitis or osteomyelitis leading to necrosis. In such persons not only is the resisting but also the reparative power low. New bone forms slowly, and is of poor quality; thus, a fracture will reunite very slowly, or the new material may make a weak union; often both delayed and weak repair are met with in the same case.

It will thus be seen that in dealing with a person who has received an injury to a bone, much must be taken into account beyond the mere fact of the amount of mechanical harm done to the part. The patient's history should be carefully gone into, and while in every case a guarded prognosis should be given, this becomes imperative if examination has revealed any constitutional weakness.

Fractures of the skull and spinal column having such close relationship to injuries of the nervous system will be dealt with in another chapter.

In like manner fracture of the pelvic bones usually owes its importance to coincidental injury of pelvic organs or tissue, and will be dealt with when considering that subject.

Contusions.—These are usually associated with similar injuries to the soft parts. If the injury is not severe, there may be contusion of the periosteum alone ; it is raised from the bone by an effusion of blood called **hæmatoma of the periosteum,** which may be completely absorbed or give rise to a thickening of the bone called **traumatic periosteal node.** If the injury be more severe, or if the person be predisposed by lowered vitality or heredity, it may be the starting-point of acute or tuberculous osteo-myelitis by supplying degenerate bone tissue for the lodgment of bacteria already circulating in the blood.

Treatment.—The limb should be elevated and placed at rest, while evaporating lotions or fomentations are applied for several days, after which massage should be adopted. Iodide of potash may prove useful in causing absorption of effusion, or even of a node.

Wounds.—Bones may be subject to contused or incised wounds from various weapons which penetrate the soft tissues deeply, while punctured wounds are usually the result of bayonet-thrusts. They should be treated on general principles. When the force which causes the wound fractures the bone, the treatment is that for fracture.

Gunshot wounds usually penetrate large bones cleanly, and fracture small ones.

Bending.—Short of being fractured, a bone may be **bent.** Bending of bone so far as adults are concerned is usually secondary to disease rather than accident, but it is possible that a person with bones made soft rather than brittle by disease may suffer from traumatic bending.

FRACTURES.

A fracture is a sudden solution of continuity in a bone. The violence required to produce this may be direct or indirect.

The **Predisposing Causes** which influence fracture are—

1. **Sex.**—The male sex are more prone to fracture than the female owing to their occupation. Females, however, more often suffer from fracture of the lower end of the radius and the head of the femur.

2. **Age.**—Young children, owing to incomplete ossification, and old people in whom there is some atrophy of bone are more liable than others to fracture.

3. **Occupation.**—Those engaged in heavy, manual work and athletes are prone to fracture.

4. Certain **Morbid Conditions**—

(*a*) General bone diseases, such as **rickets** and **osteomalacia ;** in the latter disease not only is the bone more readily fractured, but there is little attempt at repair or formation of new bone.

(*b*) Local bone disease, such as **sarcoma, caries,** or **necrosis,** which may so weaken a bone at a particular point that fracture easily occurs. The surgeon should be specially careful with regard to sarcoma, which may be unrecognized till it causes a fracture, with little or no violence to account for it.

(*c*) **Fragilitas ossium,** a curious condition, usually hereditary, leading to spontaneous fracture. There is no explanation of the pathology of this condition, since the bone seems to be normal and unites perfectly. The condition is diagnosed by the multiplicity of fractures occurring without violence. In the first fracture, where some little violence may be suspected, such a condition might be readily overlooked unless a history of the condition existing in father or mother can be elicited.

(*d*) Certain atrophied conditions predispose to fracture. These are as a rule due to age or some well-marked nerve disease, as tabes, general paralysis of the insane, and syringomyelia.

The **Exciting Causes** of fracture are—

Direct violence, where the bone breaks at the point where violence is applied.

Indirect violence, in which the bone breaks at a place more or less distant from that at which the violence is applied, as in fracture of the leg bones when a person drops from a height on to his feet.

Violence by muscular action, when the force of the muscle is too great for the resistance of the bone; it is unusual for a large and powerful bone to be broken in this manner.

Varieties of Fracture.—1. **Simple** fracture, in which there is no external wound leading to the site of the bone injury.

2. **Compound** fracture is one in which there exists a direct communication between the external air and the injured bone. The great danger of this fracture is the fear of septic poisoning, but with modern methods of treatment the results may be better than in the so-called simple fracture.

3. **Complete** fracture is one in which the whole bone is broken across either transversely or in various other directions, such as oblique, spiral, or longitudinal.

4. **Incomplete** fracture is more common than was formerly thought to be the case. The X rays have shown that a bone is frequently partly fractured which, from external examination, appeared to be uninjured. This point should be remembered, and it is always a wise precaution, especially in a workman's injury, where a bone has been exposed to violence, to have a radiograph taken.

5. **Greenstick** fracture is a partial break or bend in the bone of a young person.

6. **Comminuted** fracture is one in which the bone is not only severed, but broken into numerous small pieces. This is generally due to excessive violence, and the fracture is usually compound; the liability to sepsis is greatly increased in a compound comminuted fracture.

7. **Complicated** fracture is that in which one or more important structures are involved in the injury.

When a **joint** is involved, the injury will be serious in proportion to the health of the patient; in a tuberculous person disease of the joint may follow such an injury. A dislocation of a neighbouring joint may complicate a fracture. In this type of injury the surgeon will have to be careful to arrive at a correct diagnosis, which sometimes is not easy, especially if the fracture be close to the joint. Care should be taken in every dislocation to exclude fracture.

A **bloodvessel** may be contused, ruptured, or punctured. If an injured artery be the main one of the limb, the accident is soon made obvious by the condition of the limb below the injury, which becomes more or less numb and cold; the distal pulse is interfered with, and if all

the coats of the vessel have been ruptured, there will be extravasation of blood, and the venous return may be interfered with, leading to moist gangrene. If the terminal vessels are healthy, no permanent bad result will, as a rule, follow. If, however, the arteries are calcareous, dry gangrene may supervene.

When a main vein is ruptured, there is extravasation of blood, and thrombosis may not be sufficiently rapid to prevent congestion and œdema of the limb resulting in gangrene; even pressure on a main venous trunk produces serious œdema.

The **nerves** of a limb may be torn or compressed at the time of the accident, leading to paralysis and anæsthesia, or they may be included in the callus, which, pressing on the fibres, produces neuralgia and spasm of the muscles, and later on paralysis and anæsthesia of the part. In giving a prognosis regarding a fracture, this is a late result which should be remembered if the line of fracture be near an important nerve, but it is not one that can well be guarded against—at least, in simple fracture.

8. **Impacted** fracture is one in which the upper fragment is driven into the lower or the lower into the upper. In such an injury there is no undue mobility of the bone, but shortening of the limb is present.

9. **Separation of epiphyses** may be referred to here. It is not truly a fracture, though in some cases there is a fracture of the diaphysis associated with the injury. It occurs in young people up to the twenty-fifth year, and results from injury to the ends of the bones. Those most often affected are the humerus, femur, and radius. The periosteal covering as a rule remains firmly attached to the cartilage, and is stripped from the bone. The displacement may be mistaken for a dislocation. If the parts be not replaced in exact apposition, arrest of longitudinal growth in the bone will follow; this should be remembered in giving a prognosis. Separation of the epiphysis sometimes occurs after a very slight violence in those who are the subjects of hereditary syphilis or tuberculous epiphysitis; tuberculous disease is also likely to occur after partial detachment of an epiphysis when treatment has been neglected; a tender swelling of the bone close to the epiphyseal line, and not involving the joint, should lead us to suspect this accident.

Signs and Symptoms of Fracture.—In every fracture, wheresoever situate, there are certain local signs and constitutional symptoms which are valuable guides as to the nature of the injury sustained. They also help us to form a more or less accurate opinion as to the length of time the patient will be incapacitated, and whether there will be any untoward consequences.

Locally we have pain, swelling, and bruising of the part. There will be more or less hiding of the normal landmarks owing to extravasation of blood from the torn tissues.

Unusual mobility of the part reveals that a break in the continuity of the bone has taken place. Loss of function is necessarily present. Crepitus or the grating of the fractured ends on one another can be felt and heard. In most fractures there is a change in the shape of the limb and some deformity. Cases in which this is not marked will be pointed out later.

Associated with these local signs are the symptoms of—

1. **Shock;** this may be very slight or most severe, according to the situation of the injury, the violence which produces it, and the previous state of health of the person injured.

2. **Hæmorrhage,** more or less severe, occurs in all fractures, but should a vessel have been lacerated by the injury, it will lead to the signs already pointed out, and will increase the symptom of shock.

3. **Fracture fever** occurs some hours after the injury, and is of no gravity unless in the case of a compound fracture when septic poisoning has occurred, or in the case of a drunkard, when delirium tremens is set up. This, however, is at a later period.

4. **Fat embolism** results from the absorption of fat globules after an injury in which there occurs laceration of fatty tissue. In fractures the medullary fat is involved. If the absorption be so great that the lungs cannot deal with it, death may ensue from dyspnœa, or coma result from blocking of the cerebral vessels.

Absence of Typical Signs.—When one or more bones support the fractured one, there will be little change in the mobility of the part and little deformity, as in fracture of one bone of the leg, especially the fibula, of the forearm, or of a rib. When impacted, a fracture will not give crepitus nor show unnatural mobility, nor will crepitus be elicited when soft structures are interposed between the fractured ends, or they are widely separated, while a simulated crepitus may be given on palpating tissue into which blood has been extravasated or which is the site of subcutaneous emphysema.

Union of Fractures.—Immediately after a fracture occurs there is extravasation from the lacerated tissues, and a blood-clot is formed. After some hours this clot is invaded by leucocytes, and later becomes absorbed. There is exudation of plasma, and the connective tissue cells proliferate ; a cellulo-plastic material is thus formed round and between the broken ends of the bone ; vascularization gradually takes place, and granulation tissue replaces that first formed ; a cartilaginous or fibrous change usually succeeds, and finally calcification occurs, and bone at first soft, but gradually becoming sclerosed, is formed.

The periosteum is an important factor in the healing of bone. This structure is sometimes not completely severed by the accident.

In the process of healing an ensheathing callus is formed which is only temporary, and is reabsorbed when the true permanent callus is formed. The so-called " medullary plug " is a temporary internal callus, which also disappears after healing has taken place. If, however, the apposition is not good, both internal and ensheathing callus will remain, and it is easy to determine if a bone has been formerly broken ; while if there has been splintering of bone, the permanent ensheathing callus is likely to be large.

The time taken by the various processes of healing in bone is considerable, and as a rule it is not permanently and soundly healed for some months after the occurrence of the fracture. Consolidation takes place in about five or six weeks, but this by no means indicates that a patient will always be able in that period to begin hard muscular work which would involve the injured bone, still less does it mean that in a fracture of the lower limb the weight of the body at work can be sustained.

It is not possible to lay down any hard-and-fast rule as to when work should be recommenced, since one individual could start before another, and each case must be judged on its merits. Much will depend on the vitality of the injured person, and delayed union may make the period of repair almost indefinite. It is an interesting fact that sometimes the most unlikely persons exhibit this quality of non-union

in bones, in their case not evidently due to any lack of animal vitality.

What has been said above of course only applies to the period occupied by natural cure. When artificial means are taken to hasten repair, as by wiring or pegging the fractured ends of a bone together, the time is shortened, and a patient will be probably able to resume his occupation at an earlier date than when union takes place by natural means.

Malignant disease occasionally develops at or near the seat of fracture, and is supposed to be derived from overgrowth of callus.

In carrying out treatment for fracture, there are certain complications and hindrances to a perfect and rapid cure. Such are—

1. **Ununited Fractures.**—There comes a time when delayed union ceases to be so called, and is known as "ununited fracture." The term is sometimes loosely applied to cases in which suitable treatment, short of operative procedure, will bring about union of the fractured bone. It is better to reserve it for cases in which the bone will not unite unless artificial means of union are employed, and for those in which bony union never takes place. The causes of non-union are—(1) Defective blood-supply to the fragments; (2) local bone disease, as sarcoma; (3) general bone disease, as osteomalacia; (4) constitutional diseases, as syphilis, scurvy, or alcoholism; (5) general constitutional weakness.

2. **Delayed Union.**—This is due to (1) muscular action on the fragments producing lack of apposition, (2) want of rest of the parts, (3) a foreign body between the fragments.

The usual sites for delayed union are the patella and os calcis, the olecranon and coracoid processes, amongst small bones and bony processes, due in these examples almost invariably to muscular action; the middle of the humerus and upper or lower thirds of the femur in long bones.

3. **Disunited Fracture.**—A rare occurrence, in which a fractured bone after union becomes separated again. It is generally due to the development of some severe and debilitating constitutional disease, especially scurvy.

4. **Vicious Union.**—This is brought about by careless treatment, or neglect on the part of the patient.

5. **Hypostatic Pneumonia.**—Frequently arises in elderly persons kept too long in a recumbent position.

6. **Crutch Palsy.**—Is the result of pressure on the brachial nerves between the head of the humerus and the crutch. The musculo-spiral is the most usual single nerve to be injured.

7. **Ischæmic Contraction.**—This is the name applied to the contraction and atrophy which sometimes occurs from pressure of splints. The prognosis in a marked case is not good.

8. **Gangrene.**—May supervene as a direct result of the injury, from spreading gangrene in compound fracture, and from errors in treatment such as too tight bandaging or insufficient padding.

Treatment of Fractures.—The treatment of fractures has much altered of recent years.

Formerly a rigid apparatus, usually wooden splints followed by plaster of Paris bandages, was kept on till firm osseous union was obtained. The objection to this mode of treatment was that there remained, after the bone was healed, great stiffness and considerable

atrophy of muscles, and, if the fracture was near a joint, loss of function. In elderly persons, when the fracture was of the lower limb, the prolonged confinement in bed was conducive to the production of hypostatic pneumonia and cardiac failure.

A little movement of the ends of the fractured bone is not to be feared ; indeed, as pointed out by Lucas Champonnière, it produces earlier union. The whole modern view may be summed up by saying that the fracture should be reduced, the parts kept in apposition with as little application of fixed apparatus as possible, and early movement and massage adopted.

First aid is important in fractures in order that the patient may be removed to his home or to hospital, whichever is his place of residence during treatment, with the least amount of pain and without rendering the initial injury worse, as by making a simple into a compound fracture.

The next step is at the earliest convenient moment to **reduce the fracture** or " set " the bone, which is the popular term. This is done by relaxing the muscles which act on the fragments, after which it is frequently necessary to make extension on the distal fragment and counter-extension on the proximinal one. Having **coapted** the ends of the bone, they should be kept in place by adopting such a position for the injured limb as shall assure the **completest relaxation** of any muscles, or group of muscles, which act on either of the broken fragments. In order to retain this position, **splints** will be of great use, since voluntarily, or involuntarily, the patient will move the limb, and in most cases it is well that the splints should immobilize the joints above and below the site of injury. Having placed the parts at rest, keep them in apposition until firm union is established ; but this does not mean that the patient is, for example, to be kept in bed with a broken leg for six weeks. Movement and massage are to be adopted, and in the case of the lower limb the patient is got up on crutches.

Exceptions to the Above First Aid.—In certain cases of **impaction** the bone should be left alone and not brought into normal relationship.

In **greenstick** fracture, where the bent bone has to be straightened, there is no question of coaptation, since there are no broken ends, except when the bone has to be broken in order to straighten it, in which case the fracture comes under the head of simple fracture.

Where there is a great deal of effusion and **swelling** following fracture, the limb may be placed between sandbags for a few days till the swelling goes down, when splints may be applied.

In no case should the manipulation of the bone be postponed beyond ten days, as by that time calcification of granulation tissue has taken place, and should not be disturbed.

Massage and Movement.—Some begin the treatment after the bone is set, and before the splints have been applied ; others postpone its adoption for a few days, and circumstances may point to the latter as the preferable course. When the massage is begun at once, the coapted bones should be firmly held by an assistant, while the limb above the fracture is gently but firmly rubbed in an upward direction to empty the veins and disperse the effusion. Gradually the process is carried down over the site of injury and on to the lower part of the limb, where, by upward massage, the circulation through the injured part is improved. After this the limb should be placed at rest between sandbags or in light splints. When the massage is begun later it is

usual to let a few days elapse after the receipt of the injury. **Movements** are carried out early, especially in those fractures which are situated near joints, and are at first passive and later resisted. There is some danger if the fracture be very oblique, or where a small fragment is acted on by a powerful muscle, that the ends of the bone may come apart while massage is being carried out. This should be guarded against by the ends being held firmly together by an assistant.

Appliances—*Splints.*—These should not be complicated or cumbersome, but, on the contrary, the simpler the better. While different fractures in various positions may require special splints, it may be broadly stated that for fracture of single bones—as the humerus—a splint which surrounds the fracture is the best, and this is easily attained by using Gooch splinting. This consists of strips of wood attached to wash-leather. When applied with the leather next the skin, it encircles the bone. When the fracture is of one or both bones, where two exist parallel in the limb—as the tibia and fibula—then the splints should be in the form of a box, the top and bottom or the sides of the box being formed by Gooch splinting applied with wood innermost, or plain, deal splints cut the proper length for the limb, the sides of the box being formed of bandages or a jack towel. Tin and other metallic materials may be used in place of wood.

All splints should be carefully padded with cotton-wool, any hollows being filled up and bony projections protected by " nests " of cotton-wool. Splints should be cut accurately, and special care taken that no undue pressure is exerted at angles, such as the bend of the elbow in splints for the forearm, where the padding should be very carefully done. Splints are held in place by a piece of webbing or bandage. Bandages should be applied firmly and evenly over splints, so as not to produce unequal pressure.

Plaster of Paris.—When treatment by early massage and movable splints is for any reason not found suitable, the limb may be put up in a plaster of Paris case. It used to be a routine practice to put up a broken leg for some weeks in splints, and then in plaster of Paris ; but such a course is not now pursued. If the limb is put up in such a case soon after the fracture, when there is usually a good deal of swelling, the case will prove too large, while if the swelling should increase after the case is in position, gangrene from pressure may result. If this method of treatment is desired for any reason, the limb should be rubbed with oil, after which a flannel bandage is put on from the distal end of the limb to slightly above where it is intended to end the case. Plaster of Paris bandages are then placed in hot or cold water till bubbles cease to rise. After squeezing out excess of water, they are put on in the ordinary way. Several superimposed layers of bandage will be required. The bandages should then be rubbed over with a little damp plaster to secure them, and to fill in any small inequalities. The plaster will be set in about half an hour. The setting may be hastened by the addition of alum to the water. When it is desired to remove the bandage, the limb should be placed in tepid water, and a pair of plaster scissors used to remove the bandages.

Plaster of Paris is nowadays more frequently used in the form of *Croft's splint.* This is a movable plaster splint, and is made by shaping two pieces of flannel to either side of the limb ; the outer two are then steeped in plaster of Paris solution till they are impregnated, when they are applied over the inner layers of dry flannel, the whole being kept in position by a bandage. In removing the bandage to employ

massage, that over the front or side of the limb is cut, the back part acting as a hinge. If preferred, eyeholes may be made in the contiguous borders of the flannel before the plaster sets, and after it has become hard the two sides are laced together.

Poroplastic **felt** makes an easily applied and efficient splint, and is very useful for such a fracture as that of the neck of the humerus, where it is desirable to have a shoulder cap. The material is first heated and then moulded to the required shape. When used for a limb, the two side-pieces are placed in position and secured by a bandage.

Operative Treatment of Fractures.—If it is found difficult to bring the ends of the fractured bone into apposition, even under an anæsthetic, owing to the obliquity of the line of fracture—as occurs sometimes in the leg; or to muscular action—as in fracture of the patella; or to interlocking of fragments—as in separation of the epiphysis—it becomes necessary to operate with a view to fixing the fragments by means of silver wire, pegs, screws, or plates, according to the line of fracture and the position of the fragments. Hey Groves advocates the use of an intramedullary peg for transverse fractures. If this procedure is thought to be necessary, it is usual to allow a few days to elapse for the subsidence of inflammation, in order to test the non-efficiency of other means of treatment, and to obtain an X-ray photograph of the condition. The procedure is open to the objection of making compound a simple fracture with the possibility of septic infection, however remote. Some surgeons advocate operative fixation in fracture. Arbuthnot Lane in this country and Lambotte on the Continent are the most prominent and successful advocates of this method of treatment.

Treatment of Compound Fracture.—The treatment of these fractures differs from that for simple fractures in that there exists a wound communicating with the injured bone, and so a road is opened for septic infection.

The wound may be caused by the injury which breaks the bone, or may result from within by a sharp piece of the fractured bone penetrating the skin.

It is possible that a wound may exist over a broken bone, but not communicate with it. This should be ascertained by enlarging the wound.

It is of primary importance that the wound should be rendered aseptic. This should be carried out on general principles. If any portions of bone are completely separated from the periosteum, they had better be removed together with any soft tissue which is much bruised or lacerated. When the wound is a mere puncture, it is necessary to increase its size in order that it may be cleansed. It is unwise to conclude that because of its nature and size a wound is not septic.

It is nowadays seldom necessary to **amputate** a limb which is the site of even a compound comminuted fracture. It is especially necessary to try and save the limb when it is the upper one in a young subject. The points that will weigh in favour of amputation are—

1. Such comminution of the bone as obviously will render its repair impossible.
2. Such destruction of soft tissues as obviously will render their vitality impossible.
3. Such destruction of main bloodvessels and nerve trunks as will render the distal part of the limb deficient in blood-supply and innervation.

4. Such destruction of the limb as will render its conservation undesirable, since it will be less serviceable than an artificial one.

When amputation has been decided upon, it is well to postpone operation until the initial shock occasioned by the injury has passed off.

Separation of Epiphysis.

This is a separation at the junction of bone and cartilage. The accident occurs usually before the eighteenth year, and cannot do so after the twenty-fifth, as by then the epiphyses have united. It occurs latest in those of the shoulder, wrist, and knee, as they are the last to unite. In these situations growth in the length of bone is actively continued to a later date than in others, so that separation of the epiphysis is liable to interfere with the growth of the bone.

While injury is the cause of separation, there are certain conditions which render the accident more likely to occur—such are tuberculosis, syphilis, rickets, and scurvy. Indirect violence is more usual than direct in causing separation of epiphysis.

The lower end of the femur and of the radius are the most common seats of the accident; then, in order, the upper end of the humerus, the lower end of the humerus, the lower end of the tibia, the upper end of the tibia.

A fracture of the diaphysis frequently complicates a separation of the epiphysis, which in such a case is usually not complete. In a complete separation the cartilage usually remains attached to the epiphysis.

Symptoms.—There is unnatural mobility at the line of juncture, deformity which is not marked, pain and tenderness, loss of power, some swelling at the site of injury, while the neighbouring joint may be distended with fluid. Crepitus is present, but has not, especially in young patients, the sharp character of that met with in fracture, but is of a softer kind.

Diagnosis.—The condition has to be distinguished from dislocation rather than from fracture. The relationship of the bony points should be noted. The reduction is, as a rule, easier than in dislocation, and its occurrence not accompanied by any snap; while recurrence of the displacement is easy when the parts are not held in position.

Treatment.—This is carried out as for fracture, though early movements have to be carefully supervised. The results are, as a rule, good, union taking place by callus. Growth is, however, sometimes interfered with.

SPECIAL FRACTURES

Fracture of the Face Bones.

In fracture of the small face bones it is sometimes difficult to determine the nature of the injury, especially when, as is often the case, there is a considerable amount of swelling.

Nasal Bones.—Fracture of these bones is usually by direct violence. The best way to elicit crepitus is by grasping the organ and moving it from side to side. Should the fracture be close to the root of the nose, there is danger of fracture of the frontal bone or the base of the

skull being associated with the lesser injury, and each should be carefully excluded before giving either diagnosis or prognosis. The fracture may be complicated by severe nasal bleeding or surgical emphysema.

Treatment.—A pair of dressing forceps with the blades protected by rubber tubing are passed into the nostrils, and the broken bone raised and moulded into position, after which, as a rule, there is no need for any form of splint. If, however, the septum is displaced or there is much splintering of fragments, pieces of tubing may be left *in situ*. The patient should be warned neither to handle nor blow the nose.

In fracture of the **Lachrymal Bone** a diagnosis may be made by the interference with the flow of tears, and this feature may form an unfortunate complication. Surgical emphysema is a prominent symptom.

Fracture of the **Malar Bone** is seldom seen unaccompanied by fracture of the anterior wall of the *antrum of Highmore*, and depression of the fragments; these may be raised into position by manipulation or by an elevator passed through a small incision in the mucous membrane, anterior to the masseter.

In fracture of the **Superior Maxilla** there is often severe hæmorrhage from the branches of the internal maxillary artery. Direct violence usually causes the accident. The fracture may be rendered compound by an opening into the mouth or the *antrum of Highmore*, or on the skin of the face.

The **Treatment** consists in reducing deformity, procuring drainage, and keeping the mouth aseptic, and, if necessary, keeping the bone in position by pressure of the lower jaw, which is held up by a four-tailed bandage; or a gutta-percha splint may be moulded to the palate and alveolus.

When the **Inferior Maxilla** is fractured behind the teeth, some care is needed in diagnosing the condition. If the line of fracture be through the neck of the condyle, the process is drawn forwards and inwards by the external pterygoid muscle, while the body of the bone is freely movable and displaced towards the fractured side. If the coronoid process be detached, there is little displacement, but the process is dragged upwards. The bone is commonly broken by direct violence, and the usual site is through the body at the canine tooth. The fracture may be uni- or bi-lateral, and is often compound, involving the mucous membrane of the mouth. It should be remembered that necrosis, septic pneumonia, and pyæmia, may follow a compound fracture of this bone.

Treatment.—A four-tailed bandage, moulded gutta-percha splint, or dental splint with wire attachment to several teeth, may be used. The diet should be fluid or slops. An antiseptic wash or spray should be employed for the mouth.

The danger from fracture of the **Hyoid Bone** arises from the fact that sometimes the mucous membrane is perforated and bleeding occurs into the pharynx, or that œdema of the glottis may supervene.

The **Treatment** consists in manipulating the fragments into position through the mouth, and fixing the head and neck in a poroplastic splint. Tracheotomy may have to be performed in certain cases.

Fracture of the Ribs.

Fractures of ribs may be caused by (1) direct violence, (2) indirect violence, (3) muscular action.

When due to **direct violence,** such as a blow from, or a fall on, a blunt object, the rib gives way at the point of impact. If the blow be severe, such as would be caused by the shaft of a dray, the fragments may be driven in, lacerating the pleura, lung, diaphragm, or liver.

In **indirect violence,** as by crushing or the passage of a wheel over the thorax, the rib gives way at either end, most frequently in front of the angle.

Bennett has pointed out that the fracture takes place by a force acting in the long axis of the rib and not by mere bending, so that the ends of the fragments frequently overlap.

Ribs may be fractured by muscular violence during severe fits of coughing, or by straining. There is no displacement. Anything which causes softness or brittleness of bone acts as a contributing cause—*e.g.*, tubercle, syphilis, rickets, nervous diseases, and old age.

Lunatics are subject to fractures without marked cause, attendants often being wrongly blamed for having caused them.

In fracture of the rib, owing to the number of the unbroken bones which support the part, many of the ordinary signs and symptoms of fracture are absent. The patient is usually able to place the tip of his finger on the injured spot. The **signs** due to fracture proper are pain; crepitus, which is difficult to obtain; deformity, which is not marked; and a false point of motion. On antero-posterior or lateral pressure, pain is complained of, not under the hands (which would be the case in contusion), but where the broken fragments spring, usually at the angles of the ribs. In doubtful cases, and in cases not seen for several weeks after receipt of the accident, a radiograph should be taken.

In fracture of the first rib laceration of the subclavian muscle or of the costo-clavicular ligament will cause loosening of the attachment to the clavicle. This injury will probably cause compression of the subclavian artery.

The ribs usually fractured are the fourth to the eighth.

The **Prognosis,** if the fracture be uncomplicated and the fragments in apposition, is good. The patient should be perfectly recovered in from six to eight weeks. An uncomplicated fracture of a rib is a simple matter, and frequently a man continues at work not knowing that such an accident has taken place.

Complicated fractures are those in which the fracture is associated with injury to the pleura, lungs, heart, liver, or diaphragm.

The **symptoms** caused by intrathoracic injury are friction-rub, hæmothorax, pneumothorax, emphysema, hæmoptysis.

The pleura may be contused or lacerated, causing a localized pleurisy, with well-marked pain. Empyema may occur, and this serious condition may persist for a long time. The prognosis is not good, especially in a tuberculous subject.

Injuries to the lungs may be followed by hæmorrhage, pulmonary emphysema, abscess, and pneumonia. In these cases the lung is usually lacerated by the sharp edge of the broken rib.

Tuberculosis of the lung may follow injury. Probably tuberculous foci are present, and become active as the result of the injury.

Intercostal neuralgia is a result that may be met with, and persists for indefinite periods.

The pericardium may be injured by being penetrated by a fractured rib or by severe pressure. The heart is rarely injured, but this may occur.

Treatment.—What is required is that pain shall be relieved and the ribs kept in position. This is best accomplished by strapping the chest with broad strips of infirmary plaster, which has been rubbed on its adhesive surface with turpentine. The strapping should be carried from well below the fractured ribs to well above them, and from the uninjured side behind, round the body to beyond the sternum. Each strip should be applied during full expiration.

It is not usually necessary to keep the patient in bed.

Fracture of the **Costal Cartilages** takes place in persons of advanced age. Repair is by osseous union.

The **Treatment** consists in keeping the patient in bed with the back supported. If there is overlapping, the body is bent backwards and supported in that position. Wiring is sometimes had recourse to. Non-union, which may easily result from the accident, produces no untowards symptoms.

Fracture of the Sternum.—This is rare, but may occur in connection with injuries to the spine as the result of severe crushing.

Fracture of the Clavicle.

The clavicle is the most frequently fractured bone in the skeleton. The injury may be caused by direct violence—*e.g.*, a blow, or by indirect, as by a fall on the hand. The former is not common.

The bone may be fractured in one of four situations :

1. **The Middle.**—This is the common situation, and usually results from indirect violence. The fracture occurs between the rhomboid and coraco-clavicular ligaments, and runs backwards and inwards. The inner end of the bone is raised, while the outer end is depressed, and carried towards the mid-line. The head is somewhat inclined towards the affected side, and the shoulder carried forwards, inwards, and downwards.

2. **Fracture between the Conoid and Trapezoid Ligaments.**—This is produced by direct violence. There is little displacement, but signs of contusion, and crepitus can be elicited.

3. **Fracture at Acromial End.**—This is also due to direct violence. The outer end of the bone is found displaced forwards and downwards.

4. **Fracture at Sternal End.**—This form is very rare. The inner end of the bone is displaced upwards, but there is little or no deformity.

Complications are rare, but the large bloodvessels may be ruptured or the brachial plexus injured. If the large vessels are injured, a fatal termination may be looked for, unless the patient is within reach of immediate surgical assistance.

Injury to the nerves is unusual. If paralysis comes on at once, the prognosis is bad ; if later, it is better, as the paralysis in this case is likely to be due to pressure from blood, or the formation of callus pressing on the nerves.

Treatment.—The shoulder has to be drawn backwards, and raised. This brings the fragments into close relationship. They are manipulated into place, and the shoulder held in position by means of—

1. **Sayre's Method.**—A strip of adhesive plaster several inches in width is passed round the arm, just below the axilla, the arm is pulled backwards, and the strip is passed round the back across the chest and fixed on the back. A second piece has a small hole made in it for the elbow, and is passed from the sound shoulder across the back along the outside of the arm under the elbow, and along the forearm to the sound shoulder again, the hand of the affected side having first been placed just below the opposite shoulder, and the tip of the elbow pulled well forward. A third piece of strapping may be passed completely round the arm and chest. Before applying the plaster the skin should be dusted with a mixture of boric acid and zinc oxide powders, and the opposing skin surfaces separated by strips of Gamgee tissue. A pad should also be placed in the axilla, especially if there be overlapping of fragments.

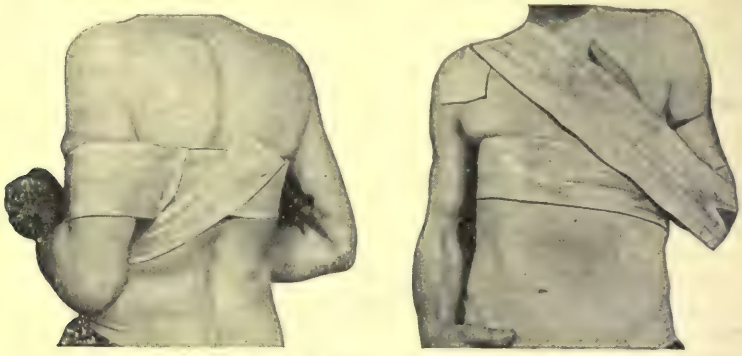


FIG. 26.—SAYRE'S METHOD.

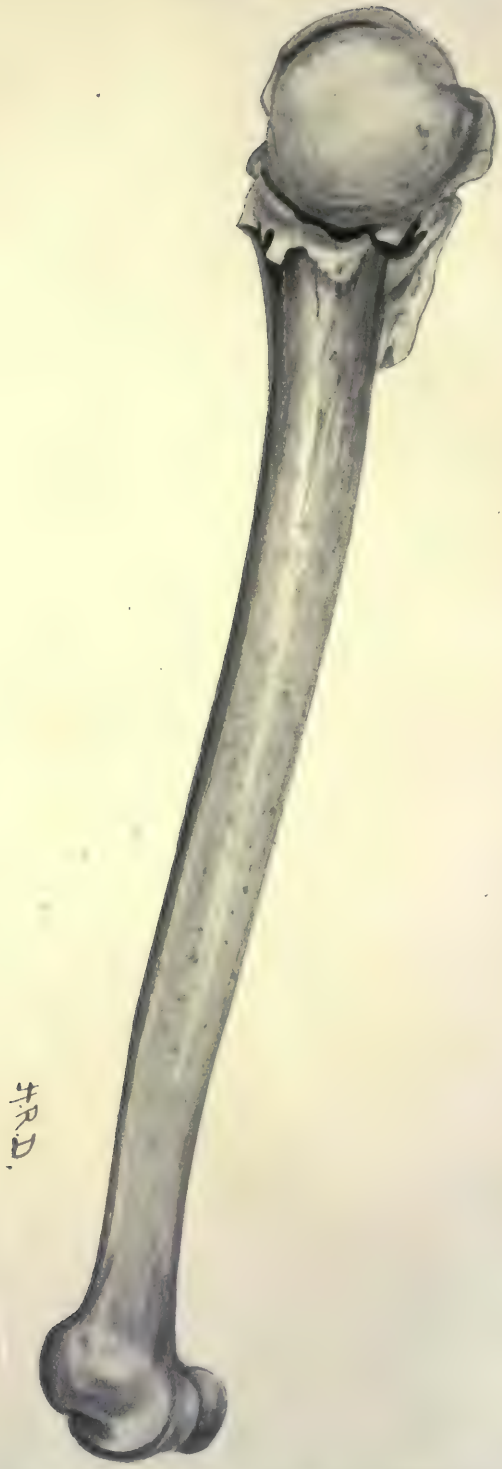
(Rose and Carless.)

2. **Duncan's Modification of Sayre's Method.**—A broad flannel bandage is used. This is passed round the arm, then across the back, bracing the shoulder backwards, under the axilla, and across the chest. A turn is then taken round the back of the elbow above the condyles, and the bandage is carried across the front of the chest to the opposite shoulder. The next turn is across the back and under the elbow of the injured side and along the forearm, which is placed across the chest with the hand just below the sound shoulder. A circular body bandage is then applied.

3. **Wharton Hood's Method.**—After reduction of the fracture, three slips of adhesive plaster are applied from immediately above the nipple, across the shoulder to a point two inches below the angle of the scapula. The middle strip, which covers the fracture, should be first applied. The forearm is supported in a sling.

4. **Rest in Bed.**—This method may be adopted when it is desired to reduce the formation of callus to a minimum. A small pillow is placed between the scapulæ and the arm bandaged to the side.

PLATE XX.



FRACTURE OF ANATOMICAL NECK OF LEFT HUMERUS.

(Museum, Queen's University of Belfast.)

[To face page 203.

Fractures of the Scapula.

The **acromion** process, **coracoid** process, or the **body** may be broken by direct violence. There is very little deformity or crepitus, and the displacement may be remedied by raising and fixing the arm and shoulder to the chest wall.

The **anatomical neck** of the bone is sometimes broken in dislocation of the shoulder.

The **surgical neck** is rarely fractured: it may be mistaken for dislocation. The line of fracture is from the suprascapular notch downwards to the lower margin of the glenoid, so that it and the coracoid process are separated from the rest of the body.

Signs.—The shoulder is flattened, the acromion process is prominent, and the arm lengthened.

Treatment.—A pad is placed in the axilla, and a leather splint moulded to the shoulder, or the shoulders may be braced back and the elbow supported by means of broad bandages.

Fractures of the Humerus.

Anatomical Neck (Intracapsular).—This form results from direct violence.

The **Signs** are loss of mobility, and great contusion of the part The head, felt through the axilla, is irregular, and it may be possible to detect a separated piece of bone in the capsule of the joint. There is some shortening of the arm, but this is not marked. Crepitus is not easy to obtain, and if impaction has taken place, it is, of course, impossible to do so. When impacted, the upper fragment is driven into the lower. There is slight alteration in the shape of the shoulder. This, however, is usually obscured by the swelling.

A large callus is thrown out in healing, and there is usually stiffness of the joint to be overcome. Sometimes there is non-union of the fragments.

Treatment.—This consists in supporting the arm in an abducted position by a sling or by bracing the shoulders back. Early massage is required. Operation is sometimes necessary to unite the fragments. If impacted, the condition should be left alone.

Surgical Neck (Extracapsular).—This, as a rule, is due to direct, but may be due to indirect, violence. The line of fracture is usually below the tuberosities and between the attachments of the short rotators and those of the pectorals, teres major, and latissimus dorsi.

The upper fragment is rotated outwards and adducted by the short rotators, and the lower is raised by the deltoid, biceps, and triceps, and drawn inwards by the muscles inserted in the bicipital groove.

Signs.—The shoulder is unaltered, a depression occurs below the acromion, and the direction of the lower part of the humerus is usually upwards and towards the axilla. Crepitus is elicited on rotation, and the upper end of the lower fragment may be felt in the axilla when the fracture is oblique. If impaction be present, the lower end is driven into the upper. There may be injury of the axillary vessels and nerves, while dislocation may complicate the case.

Treatment.—Reduce by extension and manipulation. An anæsthetic is sometimes required. An axillary pad should be applied,

and the arm bandaged and supported so as to raise the wrist to the sound shoulder, and fix the elbow in a position of abduction; or the arm may be put up in a triangular splint, so that it is placed in an abducted position. Operation must be resorted to should other methods fail. Massage should be begun about the third day.

When the fracture is very oblique, it may be necessary to attach a weight and extension to the lower part of the arm.

Separation of Upper Epiphysis.—This may occur up to the age of twenty. The end of the diaphysis is conical, while the epiphysis is hollowed out. The periosteal covering usually prevents complete displacement. The symptoms and treatment are almost identical with fracture of the surgical neck.

The Great Tuberosity.—This is fractured by direct or by muscular violence, and is frequently associated with dislocation of the shoulder. There is displacement in an upward and backward direction by the action of the supra- and infra-spinatus muscles.

Signs.—Flattening and broadening of the shoulder, bruising, and marked crepitus.

Treatment.—Union may be obtained by putting up the limb in abduction, but frequently the fragment will have to be attached by operation.

Shaft of the Humerus.—This fracture may be brought about by direct or indirect violence.

The displacement will vary with the position. When the fracture is above the insertion of the deltoid muscle, the upper fragment is drawn inwards by the action of the muscles inserted in the bicipital groove, and the lower fragment is drawn upwards and outwards by the deltoid. When the fracture is below the deltoid insertion, the displacement of the fragments is reversed.

Signs.—It is not as a rule difficult to diagnose fractures of the shaft. There is undue mobility, deformity, and crepitus; and superficial signs of injury, unless when due to indirect or muscular violence.

The chief **Complications** are involvement of the musculo-spiral nerve, either at the time of the injury or during healing, owing to its being embedded in callus. Non-union is due to interposition of muscle fibres or to defective immobilization.

Treatment.—Gooch splinting is the best, cut to fit the arm, and having pieces removed to avoid pressure on the condyles. The splints having been padded and fastened in position, the elbow is bent to a right angle, and a rectangular splint put on with the forearm midway between pronation and supination. Massage should be commenced from the second week. Union should take place in five weeks. If this fails, Bier's hyperæmic method may hasten the process. If this does not succeed, operative measures should be undertaken.

Lower End—1. Transverse Supracondylar.—This is caused by indirect violence, as by falling on the hand when the elbow is bent, or by direct violence, as by falling upon the bent elbow. The lower fragment is displaced upwards in front of or behind the upper.

Signs.—Shortening of the arm, increased thickness of the lower end of the humerus from before backwards. The relations of the bony points of the elbow are altered. The elbow is flexed, and the forearm held semipronated, and it is usually supported by the other hand. There

is apparent shortening or lengthening of the forearm according to whether there is backward or forward displacement. Dislocation of the elbow is somewhat simulated, but joint movement can be obtained, and crepitus may be elicited.

2. **Intercondylar or T-shaped Fracture.**—This consists of a supracondylar transverse fracture plus a vertical fracture through the articular surface forming a T-shaped, or, at times, Y-shaped fracture. Such a fracture is often the result of great direct violence, and so may readily be compound or comminuted. There is usually rapid effusion of blood into the joint and crepitus on moving the condyles.

3. **Separation of Lower Epiphysis.**—This usually occurs before the fourth year, and always before the fourteenth. Frequently the lesion is a combination of fracture and separation; the latter may be partial or complete. It occurs under the same conditions as a supracondylar fracture. The displacement will depend upon whether the periosteum is torn or not. It is, however, usually torn, and the displacement

FIG. 27.—SUPRACONDYLAR FRACTURE.

FIG. 28.—INTERCONDYLAR FRACTURE. (After Thompson and Myles.)

simulates that of supracondylar fracture. There is faint crepitus, and pain on pressing the fragments together.

Excessive callus is thrown out on healing, usually at the front of the joint, and full flexure is often interfered with.

4. **Fracture of the Condyles.**—The external condyle is more frequently broken than the internal. The fracture in either is partly extra- and partly intra-capsular.

There is pain and crepitus, but little displacement, owing to the ligaments of the joint not being ruptured; but displacement may occur later, and produces the deformity known as **cubitus varus** or **cubitus valgus** (see Deformities, Chapter XIV.).

5. **Epicondyles.**—These are sometimes fractured, more usually the internal.

An X-ray photograph should be taken of all fractures about the elbow-joint.

Treatment.—The best way to treat fractures in the region of the elbow is by full flexion and supination, though there may be at times exceptional cases which require other positions. An anæsthetic is often required to properly manipulate the fragments.

The supracondylar variety is reduced by extension to free the lower fragment from the triceps; then, by traction on the forearm, the fragments are manipulated into position; the arm is then flexed to an acute angle, and the forearm supinated. The bend of the elbow is padded, and the elbow fixed by a bandage applied as a figure of eight, or by broad strips of adhesive plaster, and the elbow supported in a sling. Massage should not be commenced for about four weeks, but meantime the fracture should be examined from time to time to see that the fragments are in position.

In the T-shaped fracture and fracture of the condyles, the joint is implicated, and it is sometimes better to operate and wire the fragments. It is also well to wire or peg the bone in fracture of the internal epicondyle.

In separation of the epiphysis, the bandage, as described above, is used, and also after operative treatment in T-shaped fracture.

Occasionally the ulnar nerve is involved in callus of fractures in this position, and must be liberated by operation.

It will frequently be found necessary to break down adhesions under an anæsthetic after treatment of these fractures, if massage prove ineffective.

Fractures of the Ulna.

The Olecranon Process.—This is a common injury in adults. It follows a fall on the flexed elbow, or occasionally results from muscular action. The process is drawn upwards and backwards by the triceps muscle.

Signs.—Mobility and crepitus with great distension of the joint.

Complications.—Forward dislocation of the arm at the elbow may occur, and injury to the ulnar nerve. Fibrous union may result.

Treatment.—When the displacement is not great, approximation of the fragments may be obtained by almost fully extending the arm and preserving that position by a splint extending from the axilla to the tips of the fingers, and cut to the shape of the arm. This is bandaged into position, and a broad piece of adhesive plaster is applied round the lower part of the arm to prevent traction on the fragment by the triceps. Massage and movements should be begun early.

When the displacement is great, the fragments should be wired.

The Coronoid Process.—This is seldom fractured, except as a complication of backward dislocation of the elbow. The condition is indicated by the easy reduction of the dislocation, accompanied by crepitus, and by the fact that the dislocation easily recurs.

Treatment consists in flexing the arm and supporting the forearm in a sling, or in wiring the fragments.

The Shaft.—Fracture of the shaft of one bone of the forearm is rare, and is usually caused by direct violence. It may be accompanied by dislocation of the radius.

When the shaft of the **ulna** alone is fractured, some difficulty may be experienced in arriving at a diagnosis, as there will be no longitudinal displacement. The condition is best recognized by noting that the upper part is slightly tilted forward by the brachialis anticus, and the lower one drawn towards the radius by the pronator quadratus. Crepitus may be elicited, there is pain at a particular spot, and a slight increase of mobility.

COLLES'S FRACTURE.

(Museum, Queen's University of Belfast.)

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Fractures of the Radius.

The **Head** of the bone may be fractured as part of a fracture of the elbow, and as a rule will require excision.

The **Neck** between the capsule and the tubercle is rarely fractured.

The Shaft.—When the **radius** alone is fractured, the condition is much more evident than in the case of the ulna, as the bone is superficial. Besides the evidence from direct examination of the bone, there exists characteristic loss of function in the lack of power to perform rotatory movements. Passive movements usually elicit crepitus. The difference in displacement should be remembered, according to whether the site of the fracture is above or below the insertion of the *pronator radii teres*. When **above,** the upper fragment is flexed and supinated by the *biceps* and *supinator brevis* muscles, and the lower fragment pronated and approximated to the ulna by the pronator muscles. When **below,** the insertion of the *pronator teres*, the muscle draws the upper fragment inwards, and the lower fragment is drawn to the ulna by the *pronator quadratus*. In the former variety of fracture of the radius the arm must be put up in full supination on account of the action of the supinator brevis on the upper fragment.

Colles's Fracture.—This fracture, first described by Colles of Dublin, is one fracture of the lower end of the radius with backward displacement, about an inch above the joint. The direction of the fracture is transverse or oblique from above downwards, forwards and inwards.

It is usually due to a fall on the outstretched palm, the force being received on the ball of the thumb. Fullerton has pointed out that the hand is usually in the three-quarter pronated position, and has emphasized the resulting abduction.

The accident is common in elderly women.

Displacement.—The lower fragment is displaced upwards and backwards by the force of the blow. It is rotated round the styloid process, the ulnar forming the centre, and it is rotated backwards round the line of the fracture.

The resulting deformity is that the radial styloid process is higher than usual, and is on a level with the *styloid process* of the ulna. The hand is displaced backwards, and there is a prominence at the back of the wrist and another at the front on a higher level. The hand is abducted and the carpus carried to the radial side, and there is great prominence of the styloid process of the ulna. The wrist is rotated backwards. Pronation and supination are lost; there is swelling of the joint and tenderness over the line of fracture, and sometimes over the ulnar styloid, which indicates fracture of that process—a not infrequent complication. Crepitus is sometimes difficult to elicit, and should not be sought for energetically, as great pain and increased deformity may be produced.

The fracture is sometimes impacted.

Smith's Fracture.—This is a reversed Colles's fracture, usually due to great and forcible flexion from a fall on the back of the hand.

Chauffeur's Fracture.—This is a fracture of the lower end of the radius, usually occasioned by the recoil of the crank in starting a motor engine when the handle strikes the forearm.

Separation of the Lower Epiphysis.—This accident is fairly common, and occurs between the ages of seven and eighteen. It is caused by the forms of violence which produce Colles's fracture.

The deformity is somewhat similar to a Colles's, but the palmar and dorsal projections have a direct transverse line, and the hand is not abducted, while the deformity is easily reduced, and crepitus of a soft kind is easy to elicit.

Fracture of Both Bones of the Forearm.—This is produced by direct or indirect violence. The radius is usually broken at a higher level than the ulna ; the common situation is near the middle of the shafts. The broken ends tend to be drawn towards each other by the pronator and supinator muscles, and may become united to one another. The displacement will, however, vary according to the position of the fracture and the force producing it.

There is usually no difficulty in diagnosis, all the symptoms of fracture being present.

Treatment of Fractures of the Forearm.—Treatment of all fractures of the forearm, whether of one or both bones, is carried out on a similar general principle.

An anæsthetic is often, if not usually, desirable to procure accurate reduction and coaptation. Anterior and posterior wooden splints are then applied. These should be broader than the arm to prevent lateral compression by bandages or straps, and should reach, in the case of the back splint, from the elbow to the end of the metacarpal bones ; in the case of the front one, from the bend of the elbow to the palmar flexure, having preferably a piece cut out to avoid pressure on the thumb muscles, and to allow the splint to fit more accurately to the front of the forearm. The splint should be carefully padded ; whether there should be any interosseous pads or not is a question differently answered by different authorities, but it may be stated that, as a rule, they are not required when the fracture has been properly reduced. The arm is put up midway between supination and pronation, and, if thought necessary, an external, rectangular splint may be applied in addition to the dorsal and plantar ones. This is not usually necessary. The forearm is then supported in a sling.

In treating fracture of the radius **above the insertion of the pronator radii teres**, the arm, as already pointed out, should be put up in full supination. This is an awkward position for the patient, but the arm may be retained in the position by a rectangular or other suitable splint.

In treating **Colles's fracture,** the proper reduction of the fracture is **the** important point, and when this is done, the various splints devised from time to time, as Gordon's, Carr's, etc., may be dispensed with, and ordinary back and front splints used. Splints should not be continued for long, and early free use of the wrist is carried out, massage and gentle movements being adopted from the first. The fracture is not an easy one to reduce perfectly, and frequent bad results are seen. An anæsthetic should generally be given when feasible. The surgeon then takes the patient's hand, as if in the act of shaking hands with him, while with his other hand he grasps the forearm above the fracture. The palmar surface of the wrist is rested on his bent knee ; he then makes extension through

the hand, and counter-extension through the forearm. As soon as the fragments are free, the wrist should be flexed, and the hand carried towards the ulnar side. The fragments can then be set in their proper place. That the reduction is accurate may be judged from the disappearance of deformity and the resumption of the normal relationship of the styloid processes.

Fractures of the Carpal and Metacarpal Bones.—These lead, as a rule, to little displacement, owing to the firm way in which the bones are bound together by ligaments; it is therefore frequently necessary to obtain a radiograph before a definite and accurate diagnosis can be given.

Fractures of the carpus should be treated by fixing the wrist and carpus in a palmar splint with the metacarpals hyperextended. Sometimes it is necessary to remove the fragments.

Fractures of the metatarsals are most simply treated by making the patient close his fist over a thick pad, and bandaging the hand firmly in this position. If this does not reduce any deformity that may be present, anterior and posterior splints should be used. Occasionally the fragments may have to be wired. Early massage should be carried out.

Fractures of the Phalanges.—These are easily recognized, and treatment is carried out by means of finger splints. When there is overriding of the fragments, extension may be carried out through the distal phalanx by means of plaster attachment to a rectangular splint, which is carried beyond the finger-tips.

Pelvic Fractures.—See Injuries to the Pelvis Chapter XXX.

Fractures of the Femur.

The **Neck** may be fractured at the junction of the head with the neck, and is usually completely within the capsule. This is the classical **intracapsular fracture.**

It occurs in old people frequently as the result of very slight indirect violence. Atrophy of the neck, and its more horizontal position in the elderly, predispose to the occurrence. There is a transverse or oblique break between the head and the neck. Some fibres of the capsule may connect the two parts of the bone, and the more there are the more will union be likely to take place; but the serious point that interferes with union is the breaking of all, or most, of the nutritive vessels which run upwards to the head from the neck of the bone.

Impaction is rare, and when present, the neck is driven into the head.

Displacement.—The limb is rotated outwards by its own weight and by the external rotators. The lower fragment, which, of course, includes the whole bone except the head within the capsule, is drawn up by the hamstring muscles and the quadriceps extensor, the capsule prevents much upward displacement. The limb is slightly everted and abducted, with the pelvis placed evenly. It will be found on measurement from the anterior superior iliac spine to the internal malleolus, that there is shortening of the limb varying from one to three inches. The position of the great trochanter is altered, being higher, farther back, and less prominent than in the normal condition.

The relative position of the great trochanter may be tested by Nélaton's line, Bryant's triangle, or Chiene's parallel lines.

Nélaton's Line.—A line, *AD*, drawn from the anterior superior iliac spine to the most prominent part of the **tuber ischii,** just touches the top of the great trochanter. If, therefore, this is elevated from any cause, it will be above the line.

Bryant's Triangle.—With the patient lying on his back, a perpendicular line, *AB*, is drawn from the anterior superior iliac spine; a second line, *BC*, is drawn from the tip of the great trochanter to intersect the first at a right angle, and a third line, *AC*, joins the anterior superior iliac spine and the great trochanter, thus forming a triangle. This last line is the same as the first part of Nélaton's line. If the trochanter is displaced upwards, the second and third lines, *BC* and *AC*, will be shortened as compared with those of a similar triangle drawn on the sound limb, and they will be lengthened when the trochanter is depressed. The line drawn from the tip of the trochanter to intersect the perpendicular line is sometimes called the "test line," and the alteration in its length is the important point of Bryant's triangle.

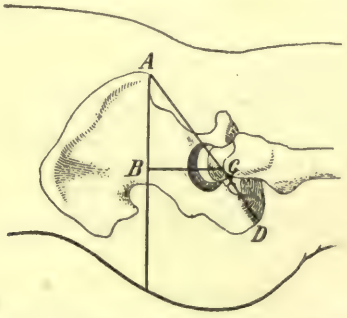
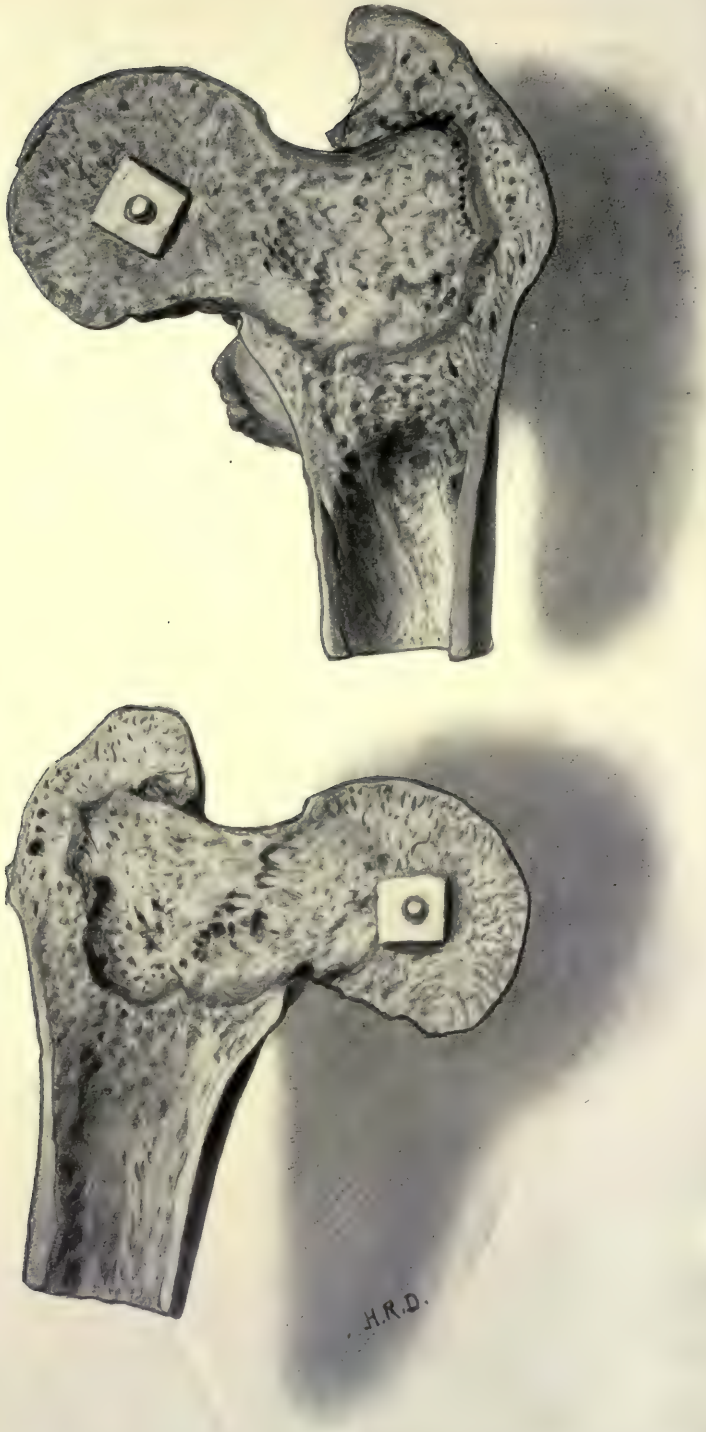


FIG. 29.—DIAGRAM OF NÉLATON'S LINE AND BRYANT'S TRIANGLE.
(Stewart's "Surgery.")

Chiene's Parallel Lines.—One line is drawn across the front of the body from one anterior superior spine to the other, the second from the tip of one great trochanter to the other. Want of parallelism, owing to raising or lowering of the trochanter, will at once be evident.

Signs of Intracapsular Fracture.—The displacement as mentioned above. Crepitus is not marked, and should not be energetically sought for, as much movement will probably increase the deformity. Immediate loss of power, pain and tenderness on attempting movement, and a particular point of tenderness indicating the place of fracture, may be made out. There is practically no bruising, owing to the slight indirect nature of the violence. It is to be remembered that these fractures **usually occur in elderly women as the result of slight, indirect violence, while extracapsular fractures usually occur in robust male adults as the result of severe direct violence.** It sometimes happens that shortening, which is not apparent, becomes so after a few days. This is owing to the fact that the periosteum of the neck and the cervical ligaments remain intact at the time of the accident, but give way subsequently In fracture, as distinct from arthritis deformans, in which also the limb may be everted and shortened, the ilio-tibial band of the fascia lata is relaxed.



SECTION SHOWING IMPACTED EXTRA-CAPSULAR FRACTURE OF NECK OF HUMERUS.

(Museum, Queen's University of Belfast.)

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When the fracture is impacted the symptoms will be modified.

Repair is, as a rule, not good, non-union or fibrous union being due to the interrupted blood-supply of the head of the bone, the difficulty of obtaining exact apposition and retaining it, and the coincident dangers of keeping elderly patients liable to this accident in bed for any considerable time. In many cases the neck of the femur becomes absorbed, and the head of the bone comes to be in contact with the trochanter, when a false joint is formed in which arthritis deformans may develop. In fibrous union there is a considerable amount of shortening, producing a marked limp, if the patient is able to get about, and locomotion can usually only be accomplished with the help of a crutch or stick.

Impacted intracapsular fracture is, as stated above, not common, when it occurs the neck is driven into the head, and bony union may take place.

Treatment.—As already pointed out, this fracture usually occurs in the elderly, for whom a prolonged period in bed is not advisable, owing to the probable occurrence of hypostatic pneumonia, bedsores, and general debility. Nor is prolonged rest of much use in order to induce bony union, since this is not the rule. Therefore, the best treatment is—

(*a*) To keep the patient in bed for a few days with the limb steadied by sandbags. If any signs of lung or heart trouble occur, the patient should be raised in bed, and very soon lifted out and placed in a chair, and later on encouraged to get about on crutches. Care should be taken not to undo impaction.

(*b*) If the condition of the patient will allow of confinement in bed, an attempt may be made to obtain bony union by immobilizing the fragments by use of Liston's long splint or Hodgen's splint. The weight and pulley may be used to counteract shortening.

Fracture of the Neck at its Junction with the Trochanter—Extracapsular.—This is caused by great violence usually applied directly to the trochanter major, and takes place in robust, adult men. While called "extracapsular," the line of fracture is usually partly within and partly outside the capsule, the joint being involved in front.

The fracture is largely in the intratrochanteric line, and is often accompanied by fracture of one or both trochanters, the neck, great trochanter, and shaft, forming the fragments.

Impaction is quite common in this fracture, the neck being driven into the great trochanter.

Displacement.—The leg is rotated outwards and everted by its own weight and the external rotators. There is well-marked shortening on measuring from the anterior superior iliac spine to the internal malleolus, and the trochanter is raised and brought nearer to the mid-line than normal. The shortening is largely caused by the shaft being drawn up by the muscles inserted into the great trochanter and upper end of the shaft.

Signs.—In addition to the displacement, there is crepitus in non-impacted cases, marked bruising about the trochanter, broadening of the trochanteric region, and relaxation of the ilio-tibial band. It is stated that the trochanter rotates round the arc of a smaller circle than normal.

Treatment.—It occasionally happens that an extracapsular fracture occurs in the aged, when it will be treated on the same lines as intra-

capsular fracture. The risks to life will be the same as in that variety. In young adults the great risk is that the limb may be shortened, and its usefulness thereby impaired.

As the fracture is most common in the young and robust, there is little danger from prolonged rest in bed.

If the displacement is great, it will be advisable to give an anæsthetic in order to procure exact coaptation and to undo any impaction which exists. When the patient is old or feeble, impaction should be left alone.

Having reduced the fracture, some form of immobilization should be employed.

Liston's Long Splint.—This splint controls the joints above and below the fracture, reaching, as it does, from the axilla to beyond the foot. That part of the splint in contact with the lower limb may be wrapped round with a small sheet, the free end of which encloses the injured limb. The upper part of the splint is fixed to the chest by means of a broad bandage. In order to prevent rotation, the lower end of the leg is placed in a foot-rest. In young children and nervous patients a long splint may be fixed to the sound leg, and the two joined by a cross-piece fixed beneath the feet. Whitman has pointed out that the best results are obtained by placing the limb in a position of abduction. In order to carry this out, when a Liston's splint is used, a hinge is placed opposite the affected hip-joint. It is sometimes necessary to correct eversion, and this may be done either by sandbags or by placing a piece of wood at the back of the knee at right angles to the limb ,where it is fixed by a figure-of-eight bandage. Counter-extension may be produced by means of a perineal band.

Hodgen's Splint is often more effective than Liston's in reducing the deformity, and allows of massage while in position. It consists of a wire frame, to the sides of which a number of strips of flannel are attached. It stretches for the whole length of the limb, over the front of which it is placed. The loose ends of the flannel are then brought round the back of the leg and fixed to the other side of the frame, the leg thus being placed in a sling, in which the limb may be suspended by cords fastened to the framework of the splint, or they may be led over a pulley fastened to an upright at the bottom of the bed to produce extension.

Extension with Weight and Pulley.—To counteract shortening, extension is employed by means of a pulley and weights. In order to attach them, strips of adhesive plaster are fixed to each side of the limb well above the knee ; to the ends of the strips broad tapes are attached. These reach to below the foot, and to the end of them a stirrup is buckled. The limb is then bandaged from the foot to above the plaster. Through the stirrup extension is made by means of a cord passing over a pulley fixed in an iron upright at the bottom of the bed. To the cord weights are attached, which will vary in amount according to the requirements of the case. The proper weight is that which extends the injured limb to its normal length, which in an average adult is about 6 pounds. Counter-extension is obtained by placing blocks under the lower feet of the bed. This method of treatment may be adopted in conjunction with the employment of sandbags or Liston's long splint.

When Hodgen's splint is used, the weight of the limb is usually a sufficient extending force.

The limb should usually be kept in splints and extension for about

six weeks, after which crutches should be used for about three weeks. In a few cases operative treatment may be employed to fix the fragments.

As **first-aid** treatment, a long splint, such as Liston's, may be used. The patient's foot, having been padded, is fixed to the lower end of the splint by a triangular bandage. The splint is then pushed down, and extension made by means of a triangular bandage passed between the legs and fixed to the top of the splint.

When the **neck of the femur is fractured in children,** it is usually of the greenstick variety, and, if complete, is generally impacted. There is shortening and some little eversion, with pain and restriction in movement; but the patient is often able to walk, though with a limp, after the accident. Careful diagnosis is therefore required, and the X rays should be employed. Treatment should aim at completely correcting the deformity, and the limb is then put up in plaster of Paris in the abducted position. Failure to recognize and treat the condition may be the cause of development of coxa vara.

Fracture of the Great Trochanter.—This is a rare accident which may result from severe direct violence, and may be treated by posture or operation.

Separation of the Upper Epiphysis.—This accident occurs before eighteen, usually about fourteen years of age. It results from falls on the leg or hip. The signs are vague at the time of the accident. It is, however, a frequent cause of subsequent coxa vara.

Fractures of the Shaft.—These injuries may be caused by direct or indirect violence, and may occur at the upper, middle, or lower third of the bone. When the fracture is transverse, it is usually caused by direct violence, and may not be accompanied by much displacement. Oblique fractures are caused by indirect violence, are usually accompanied by marked displacement, and are frequently compound or comminuted.

Fracture of the Upper Third.—The upper fragment is tilted forwards and rotated outwards by the ilio-psoas muscle and the external rotators, which are inserted at the great trochanter. The lower fragment is drawn up by the thigh muscles and rotated outwards by the weight of the limb. There is great difficulty in controlling the short upper fragment, union frequently being accompanied by shortening and deformity.

Treatment.—It is usually necessary to give an anæsthetic. If under this the apposition of the fragments can be obtained, the fracture may be treated by means of Gooch splinting or by a long Liston, and short inner and outer wooden splints at the seat of fracture. If the upper fragment cannot be brought into apposition with the lower one, it will be necessary to put up the leg in a flexed or slightly outward rotated position with abduction of the thigh. For this purpose a double inclined plane with extension in the axis of the thigh, or a Hodgen's splint, may be used.

Fracture of the Middle Third.—There is marked loss of power, with swelling and effusion of blood at the site of the fracture, which renders actual diagnosis difficult. There is shortening, which will vary according to the direction of the fracture, the lower fragment being pulled up by the thigh muscles and rotated out by the weight of the limb.

The upper fragment is usually pulled forwards and outwards by the ilio-psoas and glutei muscles. There is unnatural mobility of the part, and crepitus is easily elicited by placing the left hand firmly upon the upper fragment and gently raising the lower part of the limb. On rotating the lower part of the femur, it will be found that the great trochanter remains stationary.

Treatment.—The broken bone should be enclosed in Gooch splinting or outer and inner thigh-splints applied. Where there is shortening, extension should be made by weight and pulley, or Hodgen's splints may be used. It will be found that a considerable weight will be needed to overcome the muscular resistance. Division of the tendo Achillis is sometimes of use to relax the lower fragment. Splints should be worn for about six weeks, and crutches used for a further three weeks. Massage should be employed after the first week.

When the fracture is oblique, about an inch of shortening is liable to result. Union is often slow, and mal-union is not uncommon.

Operative treatment for wiring the ends of the bone may be called for in ununited fracture or vicious union, or where it is found impossible to bring the fragments into apposition.

In young children the best method of treatment is to sling the limb up at right angles to the body, which acts as an extending weight.

Fracture of the Lower Third.—Usually due to falls on the feet or knees, or to direct violence. The fracture is usually more or less transverse or oblique from above downwards and forwards, giving an overriding of the lower by the upper fragment.

Displacement.—The lower fragment is tilted back by the gastrocnemius, and can often be felt in the popliteal space. The upper fragment is prominent in front, and there is shortening of the limb.

Signs.—Crepitus is elicited by bending the knee, as in this way the fragments are brought together. The backward tilting of the lower fragment is apt to injure the vessels in the popliteal space, which here lie in close connection with the bone. A copious effusion of serum takes place into the knee-joint shortly after the accident, which sometimes renders immediate diagnosis difficult. Accuracy of diagnosis is helped by general anæsthesia and the use of the X rays.

Treatment.—The difficulty of treating the fracture is the difficulty of apposition, owing to the shortness of the lower fragment, and the power of the muscles acting to tilt it back. Apposition can, as a rule, only be obtained by flexing the leg on the thigh, and the thigh on the body. The limb is retained in this position by a McIntyre's splint, or, better still, a simple double-inclined wooden plane, "so constructed that the angle of flexion can be adjusted to meet the requirements of the individual case" (Thompson and Miles). This is secured by a ratchet arrangement, on which the foot and back-piece works. Hodgen's splint may also be employed, but the rods must be bent to a sufficient angle. The splints must be used for about six weeks, and massage begun early to try to avoid stiffness of the knee, which is a troublesome after-condition in many of these fractures.

It is sometimes impossible to obtain apposition of the fragments. Operation must then be undertaken to peg or to put them on a plate. Division of the tendo Achillis sometimes enables apposition to be effected.

A modification of this fracture is the **T-shaped Fracture,** which, as in the elbow, opens up the joint. It is usually the result of direct

violence, in which the bone is fractured transversely, and secondarily the upper fragment is driven into the lower, which it breaks usually into two more or less equal parts, the line passing through the intercondylar notch.

Signs.—The knee is considerably broadened. There is pain, and crepitus is elicited on pressing the condyles together. There is shortening of about one inch.

Treatment.—As for fracture of the lower third. Good after-results are interfered with to some extent by the injury to the joint.

Separation of the Lower Epiphysis.—This may be complicated by fracture of the diaphysis. It results from severe direct or indirect violence, and occurs up to eighteen years of age. The epiphysis is displaced forwards, and the lower end of the shaft presses upon and may injure the popliteal vessels.

Diagnostic Signs.—Abnormal mobility of epiphysis, presence of diaphysis in popliteal space, muffled crepitus, and the age of the patient.

Treatment.—As in fracture of lower third.

Fracture of a Condyle.—This is a rare fracture, resulting from direct violence, and diagnosed by broadening of the knee without shortening of the thigh, crepitus limited to one side, and effusion into the joint.

Treatment.—By splints or wiring.

Fracture of the Patella.

The patella may be fractured by direct or indirect violence. The former usually produces a fissured fracture without separation of the aponeurosis; little or no displacement follows, and osseous union takes place. The latter is usually produced by muscular action of the quadriceps extensor. This is the common variety, and the fracture takes place by the patella being broken across the condyles of the femur by force applied to either end. This may occur when the patient is trying to avoid falling backwards.

Displacement.—The line of fracture is irregularly transverse, slightly below the middle of the bone. The amount of separation will depend a good deal on the extent of detachment of the lateral expansions of the quadriceps extensor. When they are not much lacerated, as is usual, the separation will not exceed one inch; but when they are, the muscle is able to contract, and the separation may amount to several inches. There is then also some tilting of the upper fragment.

Signs.—The patient falls and is unable to rise, the limb being rendered useless. There is no power of extension, and the patient cannot raise his heel. The space between the fragments can be as a rule easily detected, and this space is increased by flexion, and decreased by extending the knee. The knee-joint is distended with blood and serous effusion. The torn aponeurosis of the quadriceps extensor and the free margin of the periosteum hang over the divided ends of the bone, and, by getting between them, are a frequent cause of fibrous instead of bony union.

Prognosis.—For the reason just stated, and still more on account of separation of the fragments, bony union is not usual, except in those cases where there is little displacement and tearing of the periosteum,

and where perfect apposition of the fragments has been obtained. In most cases the union is fibrous, and this, if the space covered by the band of fibrous tissue is not too great, gives a very useful limb, especially to those who are not called upon to make any great muscular effort.

At times the upper fragment becomes attached to the front of the femur, and moves with it, thus stretching the fibrous band of union; at others the shortening of the quadriceps and gradual stretching of the fibres of the uniting band allows the fragments to become further separated. By a strange fatality, a second fracture frequently occurs in those cases where bony union has taken place.

Treatment.—Three prospects present themselves to the surgeon: (*a*) He may aim at fibrous union only; (*b*) he may attempt to procure bony union by posture and splints; (*c*) he may secure bony union by wiring the fragments.

To obtain Fibrous Union.—The patient may be kept in bed for a day or two, the knee being supported upon a pillow, and daily massage employed. A strip of wide adhesive plaster can then be applied around the lower third of the thigh, after the method of Wharton Hood, in order to counteract the pull of the muscle. The patient is then allowed up, and may get about with the aid of crutches. It is important to see that the function of the joint is not impaired, and that no adhesions interfere with the action of the quadriceps.

To attempt Osseous Union by Posture.—The limb should be placed on an inclined plane in order to relax the quadriceps, and evaporating lotions, followed by massage, applied to the knee to dissipate the effusion. This having been accomplished, a large piece of adhesive plaster, cut to fit round the upper fragment, is placed on the thigh. To the ends of the plaster are fixed pieces of rubber tubing, which are fastened round the foot-piece of the inclined plane, and the limb bandaged firmly from the foot to above the knee, under the tubing as far as the lower fragment, and then carried round the knee above the plaster, thus tending to approximate still further the fragments. This position should be maintained for three weeks, when the patient is allowed up on crutches, wearing some firm apparatus, and having daily massage.

To secure Bony Union by Wiring or the Use of Plates.—This is, of course, the surest method of treatment to give bony union, but the joint has to be opened, and it is wiser not to attempt the operation if experienced hands cannot be used. No other method can secure the certain removal of tags of periosteum and aponeurosis from between the fragments. The operation should be performed about the end of the first week. The blood-clot should be carefully cleaned out, and all tags cut off. The fragments are then wired together, the sutures should not encroach on the cartilage; or a triangular plate is screwed on. The periosteum is stitched over the fracture and the wound closed. Passive movements should be begun at the end of a week, and active movements at the end of the second week.

Fractures of the Leg.

Fracture of Both Bones.—When due to direct violence, both bones are broken at the point where the violence is applied, and therefore usually at the same level. The line of fracture is usually transverse, and there is little displacement, but a great amount of contusion.

PLATE XXIII.

FRACTURE OF RIGHT TIBIA.

Vertical section showing obliteration of medullary canal by callus at seat of fracture.

(Museum, Queen's University of Belfast.)

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When due to indirect violence, the tibia is generally fractured at the junction of the middle and lower third, and the fibula somewhat higher up. The fractures are as a rule oblique from above downwards, forwards, and inwards. There is great displacement : the calf muscles draw up the heel and point the toes ; the lower fragment is drawn up and rotated out ; the upper fragment may pierce the skin, rendering the fracture compound, or form a projection underneath the skin. The axis of the upper portion of the limb is different to that of the lower. The ankle is frequently sprained when the fracture is caused by indirect violence, and the superior tibio-fibular articulation is often opened in severe fractures (Thompson and Miles).

Signs.—There is deformity, marked irregularity along the anterior border of the tibia, abnormal mobility, tenderness at the point of fracture, and crepitus. It is not always possible to determine that the fibula is also fractured, but there will be more deformity and mobility when it is, and pain may be elicited by springing the bone by pressure at both ends.

Sometimes the fractures are spiral, usually produced by torsion. These are very difficult to reduce.

Fracture of the Tibia.—In fracture of the leg, if the shaft of the tibia be alone broken, the displacement may not be great, owing to the support given by the fibula ; but on account of the size of the bone, as compared with the latter, there is usually considerable loss of function, and crepitus can be elicited, while the superficial anterior border is felt to be irregular and the lower end of the upper fragment is tilted forward by the action of the *quadriceps* muscle.

Fracture of the Fibula.—Fracture of the fibula alone is very difficult to diagnose accurately on account of its small size compared with the tibia, which supports the weight of the body easily, enabling the patient to walk almost or entirely without pain. Pain can, however, be elicited by springing the bone by lateral pressure at the top and bottom of the leg ; the point of this pain will not be under either hand, but probably at the junction of the lower and middle third, and will correspond to the spot at which in some cases constant pain is felt. It is always well to confirm by means of the X rays.

Treatment.—When both bones are broken, reduction should be carried out as a rule under an anæsthetic. Traction is made upon the foot while the knee is steadied by an assistant, and the fragments placed in apposition. The rotation outwards of the foot should be rectified, so that the inner border of the great toe, the internal malleolus, and the inner margin of the patella, come to lie in the same line. The limb should be placed in slight eversion.

When one or both bones are broken, one of the best and the simplest forms of retention is what is known as the "Edinburgh box-splint." It consists of two pieces of wood which stretch from above the knee to beyond the ankle. These are rolled in a jack towel or small sheet, one of them obliquely, to make the upper end broader than the lower, and so to fit more accurately. The leg is placed between the boards, which form the sides of the box, the back being formed by the folds of the towel and the front by a second folded towel or sheets of cotton-wool. Pressure is taken off the bony points—condyles, head of fibula, malleoli, and tip of heel—by means of nests of cotton-wool, and the back may be made more rigid, if necessary, by a third board inserted in the folds of the towel, and fitted, if required, with a foot-piece. The box is fastened to the limb by several double folds of broad bandage,

secured by means of slip-knots. The foot is fastened at right angles to the leg by a figure-of-eight bandage. The ankle should be moved early, and massage employed as soon as possible.

In oblique fractures it may be necessary to employ extension by weight and pulley.

After about three weeks lateral splints of plaster of Paris or poroplastic felt should be fitted to the leg, and the patient allowed up on crutches.

When the fracture is not markedly oblique, complete union may be looked for in from six to eight weeks; but if oblique, union may be considerably delayed.

When fracture of both bones is transverse, and there is little displacement or effusion and swelling, and in fractures of single bones, rigid splints may be applied after a few days in bed, and the patient allowed up on crutches, massage being carried out daily.

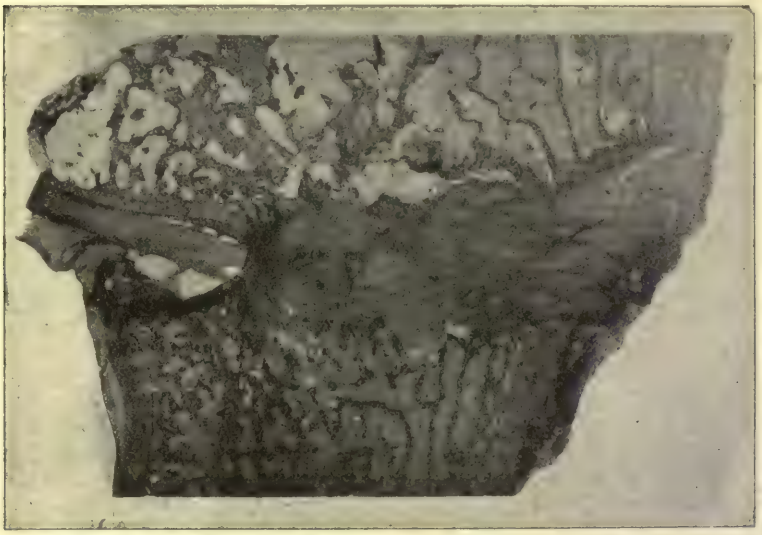


FIG. 30.—HORIZONTAL FRACTURE OF INTERNAL MALLEOLUS.
(Beattie and Dickson, "Special Pathology.")

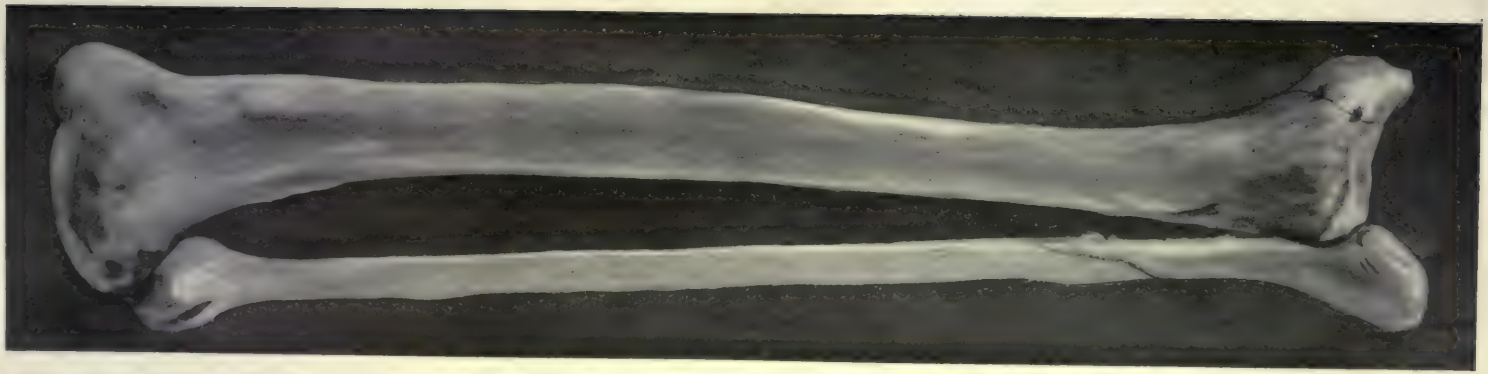
When, owing to great obliquity of the fracture or other causes, the fragments cannot be reduced, they should be cut down upon, and united by wire or plates.

Pott's Fracture.—In this fracture the lesion of the fibula is fairly constant, being a fracture from 2 to 4 inches above the ankle.

The lesions of the tibia are various. Thus there may be—(*a*) Simple rupture of the internal lateral ligament; (*b*) fracture of the internal malleolus; (*c*) rupture of the interosseous ligament together with outward or upward dislocation of the foot: this is called "Dupuytren's fracture"; (*d*) fracture of the lower end of the tibia, the upper fragment forming a prominence easily felt through the skin; (*e*) a combination of two or more of the above.

The fracture is due to indirect violence, causing eversion and abduction of the foot, and produced by such accidents as slipping off a curb, or alighting on the inner side of the foot from a height.

PLATE XXIV.



POTT'S FRACTURE, SHOWING DETACHMENT OF INTERNAL MALLEOLUS AND FRACTURE OF FIBULA 2½ INCHES ABOVE EXTERNAL MALLEOLUS.

(Museum, Queen's University of Belfast.)

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Displacement.—Two types of the fracture are seen—one in which there is little or no deformity, and the more classical, though perhaps not more common variety, where there is marked deformity. In the latter the most common position is for the foot to be markedly everted with the inner border resting on the ground, while the internal malleolus is very prominent. The foot may also be inverted, with great prominence of the external malleolus. This is caused by violent inversion, instead of the usual eversion of the foot, and is not at all so common. The foot may also be displaced backwards or upwards.

Signs.—The displacement as described: Abnormal mobility; crepitus; tenderness over fibular fracture, and over internal malleolus and the inferior tibio-fibular joint; loss of spring of the fibula; great swelling owing to bleeding and effusion into the ankle-joint.

Treatment.—When there is not much displacement of the fragments, the fracture may be treated in a box-splint or between sandbags until all swelling disappears, when a fixed apparatus, such as plaster of Paris splints, may be applied, and the patient allowed about on crutches. The splints should be removed every other day, and massage and passive movements carried out.

When eversion of the foot is a marked sign, a splint should be used to counteract the displacement. Dupuytren's splint may be used for this purpose. It consists of a piece of flat wood, which extends from below the knee to beyond the foot, having several prongs cut at its lower end. This splint is applied to the inner side of the leg, and is thickly padded from the knee to above the internal malleolus. The upper end of the splint is bandaged to the knee, and the lower end to the ankle, utilizing the prongs as levers to correct the eversion. The same bandage should correct the pointing of the toes and support the heel. This splint may be kept on for about a week, when a poroplastic one may be substituted, and massage carried out. When backward displacement of the heel is a marked sign, a special splint may be required to counteract this deformity. Such an one as Syme's horseshoe splint may be used. It consists of a flat wooden splint with a stirrup end, which is applied to the *front* of the leg with the foot fitting into the stirrup, and padded so as to give a flat surface to rest upon the leg. The splint is fixed below the knee by means of a bandage. The heel is then drawn forwards by a second bandage passed from one prong of the stirrup to the other, passing round the back of the heel, and the foot inverted by fixing it to the inner prong by means of further turns of the bandage. As soon as it is thought the displacement has been permanently corrected, the usual after-treatment may be carried out.

Separation of the Lower Epiphysis of the Tibia.—This occurs most frequently between eleven and eighteen years of age, and is usually the result of some force, producing abnormal eversion or inversion of the foot. It may be accompanied by a fracture of the shaft of the fibula. The resulting condition resembles Pott's fracture, the treatment being on similar lines as for that injury.

Fracture of the Astragalus.—This accident is usually the result of a fall on the foot, and is often associated with fracture of other bones of the tarsus. The **treatment** consists in immobilizing the foot and leg, and beginning massage early.

In some cases impaction occurs, producing a deformity resembling equino-varus, when excision of the fractured bone may be called for.

Fracture of the Os Calcis is a result of the same sort of violence as the above. There is pain on movement of the foot, which appears flat and broad. Although comminution is usually present, crepitus is not easy to obtain. The **treatment** consists in moulding the foot into its normal shape and supporting it, care being taken, by means of early massage and movement, to prevent resulting stiffness and loss of function.

The posterior tubercle of the os calcis may be torn off by violent contraction of the calf muscles. This fragment with the tendo Achillis is pulled up for a distance of several inches. The calf muscles should be relaxed and the foot extended to allow of reduction of the fracture, or the fragment may be fixed in position by open operation. Pain may be present for a considerable time after this injury.

Fractures of Metatarsal Bones and Phalanges.—These fractures are not common unless in a severe crush of the foot from direct violence. Occasionally it has been found that inexplicable pain in the region of the metatarsus is due to a fracture caused by slight injury. Fracture of a metatarsal bone frequently gives rise to aching at night, or when the patient remains standing for a long time.

These fractures may be treated by means of rigid or moulded splints.

For **radiographs of fractures,** see Chapter IV.

DISEASES OF BONE

In most textbooks the long list of bone troubles, the result of disease of various parts of the bony structure, are discussed in a separate chapter from injuries, yet in reality many of these conditions are due to traumatism in the first instance, occurring in those who are debilitated or constitutionally diseased. In such cases the most trivial injury to bone tissue often produces more or less inflammatory change.

The nomenclature which divides such changes in bone is useful for purposes of differentiation, but it is extremely unlikely that any condition of inflammation of bony tissue is limited to the one part indicated by its name, and does not to some extent affect others.

Definitions—*Periostitis.*—Inflammation of the periosteum due to trauma, infective organisms, tubercle, or syphilis.

Osteomyelitis.—Inflammation beginning in the marrow and spreading thence to the bone, due to trauma in predisposed subjects, infective organisms, tubercle, or syphilis.

Osteitis.—Inflammation of bone as distinct from periosteum or bone marrow. This never occurs as a distinct entity.

Epiphysitis.—Inflammation of the epiphysis.

Conditions which result from Inflammation in Bone—*Osteoporosis.*—The absorption of the bony framework, rendering the bone more porous, the result of **rarefying osteitis** caused by various diseases.

Caries.—A condition which may be likened to ulceration of the soft tissues, in which there is a crumbling of the hard part of the bone. Granulation tissue forms in the marrow or under the periosteum ; the bone in contact next becomes eroded, and there ensues a complete caseation, or in some cases liquefaction, of the granulation tissue, leading to destruction of the framework of the bone. In some cases there is suppuration, in others this does not occur. The process is then referred to as **caries sicca,** or dry caries, common in certain tuberculous conditions.

Necrosis.—The resulting separation of a piece of bone—a sequestrum—in certain inflammatory conditions. When the sequestrum is superficial, the term " exfoliation " is used. Necrosis is to be compared with sloughing in the soft tissues. Necrosis, as contrasted with caries, may be said to be death of bone *en masse* instead of in particles. It is usually the result of acute disease, while caries is the result of chronic disease.

Involucrum.—The sheath from which new bone is formed to replace the sequestrum.

Cloaca.—The opening from the surface to the diseased bone.

Sclerosis.—A condition resulting from chronic inflammation in which the bone is hardened and thickened, owing to the laying down of new bone. It is frequently a result of syphilitic disease. It may be compared to fibrosis of the soft tissue.

It should be remembered that disease of bone may begin in the periosteum and spread to the medulla, or begin in the medulla and spread to the periosteum, so that at different stages of disease one or all the tissues of the bone may be affected.

PERIOSTITIS.

Inflammation beginning in, but not as a rule limited to, the periosteal covering, may be either acute or chronic. The acute condition arises usually as a result of injury applied directly to the bone, and may involve the skin or not according to its nature. The periosteum becomes swollen and thickened, owing to exudation into its substance. In favourable cases this will become absorbed ; in others a superficial necrosis or death of a part of the bone under the injured periosteum occurs, probably owing to admission of pyogenic organisms through the injured skin ; or chronic periostitis may be set up, and the bone and periosteum become permanently thickened, giving rise to what is termed **chronic osteo-periostitis,** commonly called a **" node."** This is more likely to be the case where there is a rheumatic or syphilitic history. There is also a diffuse form, which commonly arises from a deep-seated affection, and so comes from within, and may go on to involve the whole bone. This is usually due to tubercle or syphilis.

The characteristic symptom of periostitis, acute and chronic, and also of osteo-periostitis, is an intense **aching** pain, worse at night, and in the case of the latter condition, tenderness over a particular spot due to the formation of a localized abscess. There is usually a history of an accident, and frequently of some constitutional disease.

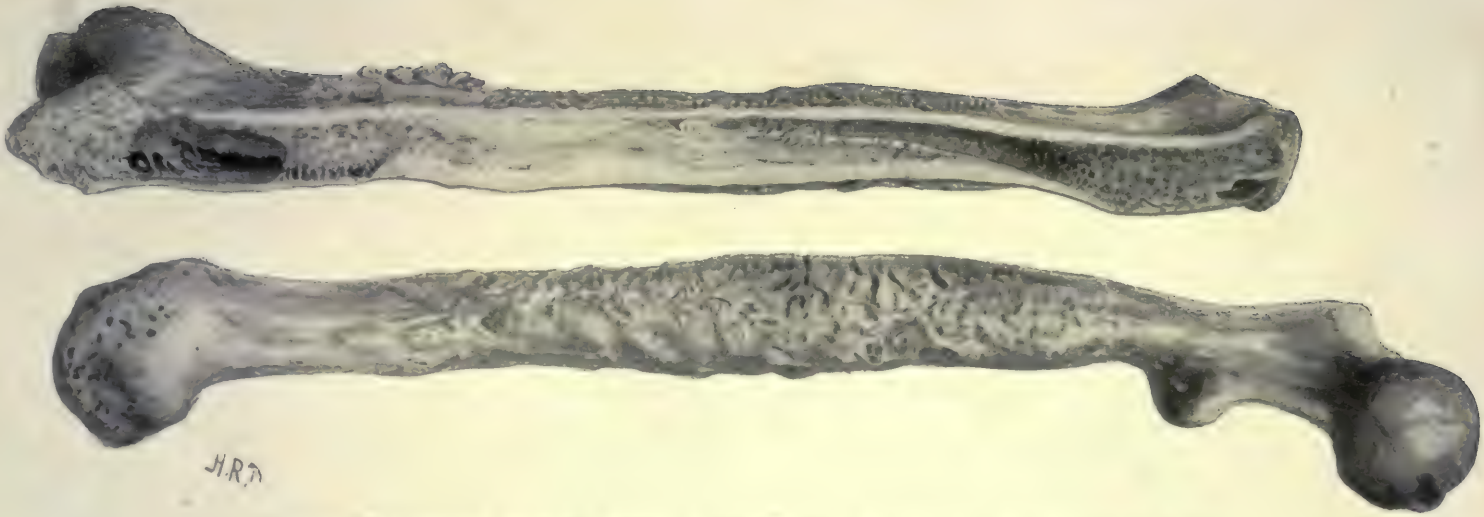
Treatment.—In the early stages rest and elevation of the part, with the application of hot fomentations, may suffice. If the symptoms do not subside, an incision should be made down to the bone through the periosteum. This may prevent suppuration if done sufficiently early. A smart purge should be given, and general constitutional treatment carried out.

OSTEOMYELITIS.

Acute Infective Osteomyelitis.—This condition often arises in young persons of a tuberculous strain, and is frequently regarded as a disease process pure and simple, having no traumatic origin. This is because the trauma, usually a strain or wrench rather than direct violence, has been lost sight of by the patient. It is a fact, however, that such a trauma usually determines the commencement of the disease by lowering still further the resistance at some particular spot, and so giving a suitable ground for the attack of the micro-organisms already circulating in the blood. The disease will spread in the line of least resistance, and its later manifestation will therefore depend on its starting-point. Thus, if it spread towards the surface, a subperiosteal abscess may form, and the body of the bone remain more or less uninjured ; on the other hand, if the disease begins or spreads centrally, practically the whole diaphysis is destroyed. Occasionally, though beginning centrally, if the patient's health is fairly good, the disease does not spread far, and a chronic abscess of the bone occurs at or near the first point attacked.

The micro-organism usually responsible for this condition is the *Staphylococcus pyogenes aureus*. Others may, however, be present, as the *Staphylococcus pyogenes albus*, pneumococcus, *Bacillus coli communis*, or the typhoid bacillus.

PLATE XXV.



CHRONIC PERIOSTITIS, SHOWING NODULAR SURFACE AND FORMATION OF NEW COMPACT BONE.

(Museum, Queen's University of Belfast.)

(To face page 222.

The **Symptoms** will vary somewhat according to the causative organism. There is usually high fever and great pain ; the limb soon becomes swollen and congested. Should the trouble be superficial, an abscess forms early under the periosteum, which, bursting through this covering, burrows along the muscular planes. When the abscess is opened, dead or dying bone is usually found. The relief of tension may possibly save the bone, but as a rule it is too far gone, and a considerable portion has to be removed. Should the osteo-genetic powers of the periosteum be destroyed, repair is, of course, impossible.

Prognosis is serious, due to the danger of toxæmia in the acute stage and to exhaustion from long suppuation, with possible amyloid disease in the chronic one. If treatment has not been both prompt and efficient, loss of function of the part may result, and in any case a prolonged period of convalescence may be counted on.

Treatment.—In the early stages Bier's hyperæmic treatment is of great service. When pus has formed, it should be liberated by cutting through the periosteum, and trephining or gouging the shaft, so as to open up the medulla. All soft material should then be scraped away, and the cavity drained or packed. As an alternative to this, the skin wound may be sewn up, leaving sufficient space between the stitches for drainage, and hyperæmic treatment renewed. These measures may probably prevent necrosis. When total necrosis has occurred, the sequestrum should be cut in two, and each end removed from the epiphysis. Amputation may be called for in such cases, as the limb may prove useless, and also if toxæmia threatens life.

In cases where partial necrosis has taken place, the portions of the periosteum and bone-marrow which have retained vitality resume their functions. The dead bone or sequestrum becomes surrounded by a sheath of new bone—the involucrum—in which are defective spots caused by the destruction of the periosteum where pus has made its way to the surface ; these are the cloacæ, and usually correspond to the skin sinuses. The internal surface of the involucrum is lined with granulation tissue, which, when in contact with the bared, dead, or dying bone, eat into and partly absorb it. If, on the other hand, the dying bone is in contact with pus, it remains hard and even. The dead bone is thrown off by the granulation tissue and the osteoclasts, to become loose in the cavity of the new sheath.

It was formerly the custom to wait until the dead bone was entirely separated before removing it, but this rule is not now always followed. The dead bone is usually recognized by passing a probe through the cloacæ, by which means it may also be ascertained if it is loose.

To remove a sequestrum, the limb should be made as bloodless as possible, and existing cloacæ enlarged, or, if two are conveniently situated, made into one. All dead bone and granulation tissue should be removed, and the cavity disinfected. It may then be packed with iodoform gauze, or grafted with bone. Mosetig Moorhof has suggested that, after disinfecting and drying the cavity with hot air, it should be filled with a mixture of iodoform, oil of sesame and spermaceti, in the proportion of 60 parts of the former to 80 parts each of the latter two. The wound is then sewn up without drainage.

Relapsing Osteomyelitis.—This variety tends to cure and to return at intervals of longer or shorter duration. It is marked by slight constitutional symptoms, slow formation of pus, which may escape by an old channel or make a new one. When a sequestrum forms, it

is usually deep, and, owing to the slowness of the destructive process, is thickly encased in new bone.

The attacks tend to become milder. The type met with in mature adult life is usually of this variety.

One form taken by relapsing osteomyelitis is **Brodie's abscess.** This is a circumscribed collection of pus situated in the centre of the bone near the ossifying junction, and usually at the upper end of the tibia. The abscess is of varying size, and usually occurs in young adults who have been the subject of one or more attacks of osteomyelitis, perhaps years previously.

The **Symptoms** are local deep-seated pain, at first vague, but later referred to the centre of the bone, and boring in character. The pain is increased on movement, and there are acute exacerbations at night, when the pain becomes excessive. As the abscess increases, the period of freedom from pain becomes shorter. Local tenderness is revealed by pressure. The neighbouring joint may become affected by the abscess bursting through into it, or merely by hydrops of an intermittent character.

Treatment.—For recurrent attacks of osteomyelitis, when there is thickness of the bone and severe pain, blisters should be applied ; and if they fail to give relief, the periosteum should be cut through and the bone opened by chisel or trephine. When there is suppuration, the pus should be liberated, the sequestrum, if any, removed, and drainage secured. When a Brodie's abscess forms, the bone should be drilled till the pus is found, when the cavity is cleared and packed.

Acute Septic Osteomyelitis is always the result of trauma, and is due to infection from without by staphylococci or streptococci. The symptoms are acute pain developing with a rigor in the course of septic traumatic fever. Locally there is found gangrenous tissue around dead bone, the part having an intense fœtor. The dangers are pyæmia and locally considerable death of bone by central necrosis. Should the patient recover from the acute stage, the period during which he will be incapacitated will be considerable, and there is danger of hectic fever during the period of separation of necrotic bone. If this is safely passed, the part may recover with a thickening of the bone.

Treatment.—The wound should be opened up, all the medullary tissue scraped out, and the cavity drained. If pyæmia supervenes, amputation is indicated.

Chronic Osteomyelitis.—Apart from tuberculous and syphilitic disease of bone, there exists a chronic form of osteomyelitis caused by pyogenic organisms. It may produce thickening of bone, suppuration, or abscess formation.

There is a form of chronic disease called by Paget **quiet necrosis,** which is characterized by necrosis without suppuration. It is a rare condition occurring in adults, and gives rise to pain and tenderness, with an increasing size of the bone shaft. The condition resembles sarcoma, but the swelling is not so marked. It also closely resembles tuberculous or syphilitic disease.

PLATE XXVI.

ACUTE OSTEOMYELITIS OF TIBIA, SHOWING NECROSIS WITH SEQUESTRUM LYING IN CENTRE OF BONE.

(Museum, Queen's University of Belfast.)

[To face page 224.

TUBERCULOUS DISEASE OF BONE.

This may be the result of an inflammatory condition produced by injury; indeed, it seldom occurs without such a history, though the result seems out of all proportion to the cause, but injury can only be regarded as an exciting cause in the tuberculous subject, the tissues being already disposed to a manifestation of the disease.

Tuberculous disease of bone is of two types, involving either the periosteum or the cancellous tissue as a starting-point.

In **Tuberculous Periostitis** the symptoms are much the same as in the non-tuberculous variety. If sepsis is not admitted, there is less tendency to involve the subjacent bone, especially if the compact bone is at all thick, and the tuberculous abscess may burst, or be opened, externally leaving the subjacent bone unharmed; if, however, the compact bone be thin, the cancellous tissue is involved, leading to **tuberculous osteitis.** This may be secondary to periostitis, or be a primary condition. The bone becomes enlarged and painful; the pain is not severe, but is worse at night. After a time an abscess forms which bursts, leaving a sinus that leads to the interior of the bone. Sometimes the abscess becomes chronic, being circumscribed by thickening of the bone around the cavity; this usually occurs in the ends of the long bones.

Tuberculous periostitis has to be distinguished in its early stages from a gumma, chronic osteomyelitis of pyogenic origin, and from sarcoma.

Tuberculous periostitis is most common in the ribs and vertebræ.

Treatment.—Removal of pus and diseased bone, and anti-tuberculous treatment.

Tuberculous Osteomyelitis.—This is most often seen in the phalangeal, carpal, and tarsal bones. In children it frequently assumes the type of **dactylitis,** as a localized swelling over a metacarpal bone or phalanx. The tuberculous process expands the bone, and frequently breaks through, forming a cold abscess. The treatment may be conservative, by means of Bier's hyperæmia, or the open operative method; the latter must be adopted when pus has formed. In adults there is often a diffused thickening of the bone and the formation of sequestra. By extension, the neighbouring joints, the tendon sheaths, and the neighbouring bones, are frequently involved. This is specially the case in the wrist and ankle.

Thickening of the bone sometimes results from a very chronic type of the disease. Diffuse softening of bone is rarely seen, and only in rapid cases. When a chronic deep abscess forms, the pus is surrounded by a thick pyogenic membrane, and the bone is thickened, the sclerosis extending at times up the shaft of the bone.

The general **Signs and Symptoms** are—Pain, in proportion to the depth of the process and the amount of pressure; swelling of the bone and overlying soft parts; an abscess, which is not accompanied by signs of inflammation, and frequently is the first indication of the presence of the disease. Fever is not as a rule marked, or usually present, unless sepsis has been admitted. If joints are affected, there is immobility, pain and swelling.

Treatment.—Constitutional, rest to the part, and passive hyperæmia in suitable cases.

If an abscess forms it is laid open, sequestra removed, and all diseased tissue scraped away by a Volkmann's spoon, and the cavity packed or drained. Amputation may be indicated for a hand or foot which is extensively diseased; but the more conservative treatment for removal of the diseased tissue, followed by injections of tuberculin, is often sufficient to arrest the disease and save the limb.

SYPHILITIC DISEASE OF BONE.

Syphilitic disease of bone is sometimes the result of injury, in an infected subject, starting an inflammation, from which either a node or a gumma develops. The former often begins as a chronic periostitis, which gives the symptoms of the non-specific condition; the latter may occur as a subperiosteal gumma, leading to caries of the subjacent bone, coincident with which there may be sclerotic thickening of the surrounding parts, or it may form in the interior of the bone leading to gummatous osteomyelitis, having the signs and symptoms of a diffuse osteo-periostitis.

Diagnosis of specific affection of bone is not always easy, especially when all knowledge of the disease is denied, but may be arrived at by going carefully into the patient's medical history, and by the effects of anti-specific treatment, though this is not always effective in some of the forms of bone trouble which are produced.

Syphilitic **osteo-periostitis** of the long bones has been mistaken for malignant disease, from which it is distinguished by its greater rapidity of growth, other evidences of syphilis being present, and, if necessary, by an exploratory incision.

For further consideration of the subject, see Syphilis (Chapter XXXIII.).

DISEASES OF NUTRITION.

Rickets.—This disease occurs usually in the first and second years of life, except the variety known as **late rickets,** which occurs at puberty. The disease is associated with disturbance of nutrition, and is attended with certain characteristic changes in the skeleton.

It is most common in large centres of population, in cold, damp climates, and amongst the children of the very poor. In breast-fed children it is rare, except when lactation is too prolonged, or lasts into pregnancy. In hand-fed children the disease is common, especially when the food is exclusively farinaceous or lacking in fats, proteids, and salts of lime, or if containing them, in such a form that they cannot be properly assimilated. Severe forms of rickets are found in conjunction with congenital syphilis.

Symptoms.—There is anæmia with marked deficiency of red cells, the muscles are flabby, the bones soft and easily bent, the ligaments easily stretched. There is a tendency to profuse perspiration, especially about the head, and the child is restless, throws off the bedclothes, and resists being handled. The temperature is frequently subnormal. Catarrh of the mucous membranes is common, leading to diarrhœa, vomiting, laryngitis, bronchitis, or broncho-pneumonia. The abdomen is frequently prominent, and the liver and spleen enlarged.

The nervous system is affected, and there are frequently convul-

PLATE XXVII.

SYPHILITIC CARIES OF THE SKULL.

(Museum, Queen's University of Belfast.)

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PLATE XXVIII.

RICKETS, SHOWING THICKENING AT JUNCTION OF EPIPHYSES AND SHAFTS OF BONE.
At this place there is irregular ossification.

(Museum, Queen's University of Belfast.)

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sions, laryngismus stridulus, and tetanus, especially affecting the hands and feet. Two types of patient are seen ; the one thin, the other fat and flabby.

The bony changes found in a case of rickets are—

In the Cranium.—Thin patches, from deficiency of the inner table, (craniotabes); thick processes of bone, especially over parietal, frontal and occipital bones. The head is flat from before back, the forehead is square and projecting. The fontanelles remain open for an abnormal time ; the teeth, late in erupting, are deficient in enamel, irregular, shed early, and may be marked by a notch having the small segment of a circle.

In the Thorax.—Bending of the ribs at the cartilage junction. transverse groove at the level of the lower end of the sternum, or horizontal grooves at the cartilage junction.

In the Spine.—Lateral or angular curvature, which may become permanent if not corrected early.

In the Pelvis.—Contracted and flattened from before backwards ; the conjugate of the brim is diminished. The sacro-vertebral angle becomes more acute. The triradiate pelvis, produced by pushing in of the acetabula, is sometimes found.

In the Long Bones.—Enlargement of the epiphyses, bending, especially of the leg bones, producing various deformities, as genu varum, valgum, recurvatum, etc.

Some of the deformities, such as those of the pelvis and lower limbs, are usually only found after the child begins to walk.

For deformities caused by rickets, see Deformities (Chapter XIV.).

Pathology.—The epiphyseal cartilage is wider and more vascular than normal. The zone of proliferating cells is thickened, and the cells are irregularly arranged, and are in excess in proportion to the matrix. The zone of calcified cartilage is thickened. Ossification is very irregular, portions of cartilage are left in the middle of ossified tissue, and these may form the starting-points of cartilaginous tumours.

In the shafts of bones the subperiosteal layer of bone is excessively vascular and spongy. Compact and cancellous bones have large and numerous vessels, and the bony tissue is less in amount, while the Haversian canals are wider than usual.

The bones, on the whole, are thicker, but much weaker than normal, containing 20 per cent. less earthy material. Following the abatement of the disease, bone becomes denser than normal, the normal curves are exaggerated, and they may be filled by buttress-like masses of new bone. Premature ossification of the epiphyseal cartilages leads to interference with the growth of the bones. Greenstick and other fractures are predisposed, too.

Varieties of Rickets.—*Fœtal Rickets* is sometimes met with, various deformities and fractures being present at birth.

Scurvy Rickets.—Occurs in children of the well-to-do who have been brought up on certain patent foods. There is a sudden onset, with high temperature, tenderness of limbs, and periosteal hæmorrhagic swellings are usually present over the femur or tibia. The epiphyses are sometimes found to be detached, and spontaneous fracture may occur. The gums are spongy, and hæmorrhages may occur from the mucous membranes.

Adolescent Rickets.—Occurs about the period of puberty. Its effects are confined as a rule to the long bones, and there is little constitutional disturbance. It is believed to be a recrudescence of infantile rickets.

Treatment of Rickets—Diet.—This should contain fresh proteids and fat in an easily digestible form: fresh milk diluted with lime water or peptonized, raw-beef juice and fruit juices, cream, and eggs. The general surroundings should be improved. Of drugs, the most useful are phosphorus in cod-liver oil, and phosphate of iron.

Surgical treatment in the acute stage consists of preventing deformities by proper nursing; in the children of the poor, splints and bandages must be largely relied upon. To correct the results of rickets, osteotomy or other operative procedure will be required for children of six and upwards, for those under that age much may be done by massage, and keeping the child off its feet. For spinal curvature in the very young, the child should lie upon a hard mattress, and massage should be applied to the muscles of the back; if older, a double Thomas's splint is applied, to let the child get about.

For achondroplasia, osteomalacia, osteitis deformans, acromegalia, see Deformities (Chapter XIV.).

NEW GROWTHS IN BONE.

A bony tumour may grow from the periosteum, marrow, or epiphyseal cartilage.

Primary tumours are those which originate in bone, and are of connective-tissue type. They are—

(*a*) *Innocent:* Osteoma, chondroma, fibroma, myxoma, lipoma, angioma, myeloma, and endothelioma.

(*b*) *Malignant:* Sarcoma.

Secondary tumours are those which invade the bones by metastasis or spread directly from neighbouring tissues. They are—

(*a*) *Innocent:* Secondary tumour from thyroid gland, which may prove to be malignant.

(*b*) *Malignant:* Secondary cancers and sarcomas.

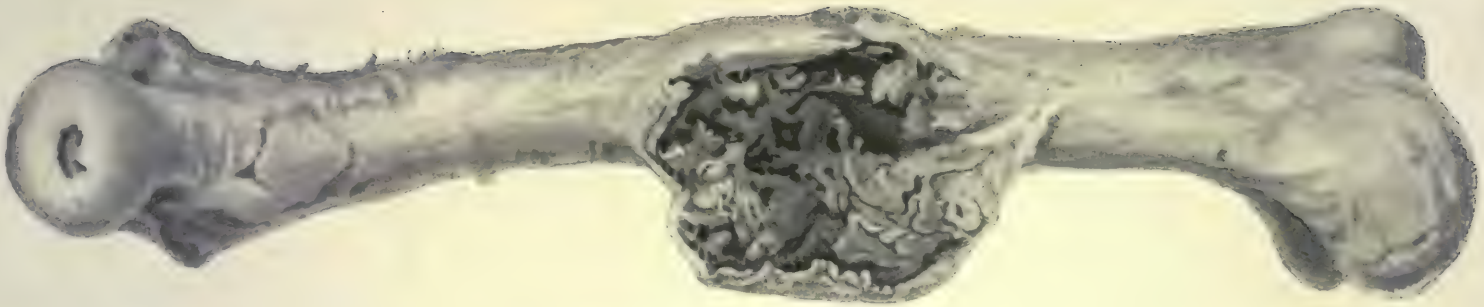
For innocent bony tumours, see Tumours (Chapter VIII.).

Primary Malignant Tumours—Sarcoma.—Sarcoma of bone may be started by an injury; certainly the history of one is frequently obtained. It is necessary to consider the question of **diagnosis** from ordinary inflammatory conditions, which are often simulated. Endosteal sarcoma, in the early stages, may be mistaken for chronic osteoperiostitis, gumma, or deep abscess. The less rapid growth of the malignant tumour is a guide, but, short of an exploratory incision, a decision is sometimes impossible. In the later stages egg-shell crackling and cystic changes will help to clear up the diagnosis.

Periosteal sarcoma may be mistaken for a deep abscess or a periosteal node. The tumour is, however, more round of edge and irregular in consistency; but again exploration may be necessary. It is always well in doubtful cases to have the help of the radiographer for the purpose of diagnosis.

Endosteal Sarcoma.—This usually grows from the cancellous tissue at the ends of long bones. The bone becomes thinned, and gives the sensation of egg-shell crackling. At first there is general enlargement of the bone. Pain is an early symptom, but there is less than in inflammatory conditions. Spontaneous fracture may occur, and at a late date the soft tissues become involved. It differs from periosteal sarcoma in that it is a central growth which gradually thins the

PLATE XXIX.



LARGE ROUND-CELLED SARCOMA OF FEMUR.

(Museum, Queen's University of Belfast.)

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bone, whereas the latter begins on one side of the bone and grows out, the spicules of the bone in the tumour being arranged in a characteristic way almost at right angles to the axis of the bone.

The tumour may be formed of round or spindle cells. The former is one of the most malignant tumours of bone ; it grows rapidly, and quickly causes death by metastatic growth.

There is pain of a constant, dull, aching character, which is worse at nights, but is not increased by use of the limb.

The swelling which forms is fusiform or globular, and due to expansion of the bone. It is at first hard, but later egg-shell crackling may be detected.

Periosteal Sarcoma.—This tumour may be round or spindle celled. It is usually very malignant. Its growth is rapid, and at first painless. The tumour is fusiform and regular. Crepitation may be elicited on firm pressure, from the crushing of the framework of the new growth. It is vascular, and may pulsate, and the veins of the overlying skin are enlarged.

Treatment.—Early amputation, well above the disease. In cases which are inoperable, Coley's fluid may be injected.

The group of mixed tumours, **fibro-, chondro-** and **osteo-sarcomata**, have been referred to under Tumours. In all of them the fully formed preponderates over the cellular tissue. They grow from the deeper layers of the periosteum, from a projection on the surface, and may surround the bone or invade its interior and fill up the spaces with bony material. The portion of the tumour next the bone is hard, and from it radiate fine spicules of bony material. The peripheral part is formed of sarcomatous cells, which invade the overlying soft tissue. The most common situation is in the bones of the lower extremity. The tumour spreads by the veins, and metastatic growths are met with, chiefly in the lungs.

For these tumours, **Treatment** by resection of the infected bone is often efficient and amputation may be obviated.

Pulsating Hæmatoma (Aneurism of Bone).—Some of these are derived from congenital angiomata. The majority are due to changes in sarcomata, by which the blood-spaces are developed at the expense of the tumour, so that the latter may entirely disappear and leave a large blood-space communicating with the arteries of the limb. There is a pulsating tumour, having the characteristics of an aneurism, but with egg-shell crackling.

Treatment.—As for aneurism, if innocent ; as for sarcoma, if malignant.

Myeloma (Myeloid Sarcoma).—As has been stated under Tumours, this growth is not really a malignant one, though formerly classed as a sarcoma. It is chiefly formed of large giant cells. On section, the tumour has a brown appearance, is very vascular, and therefore tends to bleed and form a blood-cyst.

Myeloma is a common form of bone disease, which occurs between twenty-five and forty. Its seat is usually the upper end of the tibia or lower end of the femur.

The tumour grows slowly. There is little pain, and it may not be recognized for a long time, unless the bone is examined by the X rays. As the bone is expanded, it may give egg-shell crackling on pressure.

The tumour is also met with in the jaw, springing from the marrow or the periosteum of the alveolar process.

FIG. 31.—MYELOID SARCOMA OF HEAD OF TIBIA.
(Beattie and Dickson, "General Pathology.")

Treatment.—In early cases it is sufficient to trephine or gouge the bone and scrape out the growth. Later it will be necessary to resect the portion of bone, and when in a suitable position graft in a piece from the corresponding bone of the other limb (Mikulicz).

Secondary Malignant Tumour.—**Carcinoma** occurs as a fairly common disease. Its characteristics will depend on the nature of the primary growth. It may spread by metastasis or by direct extension. The former type is most frequently met with, following cancer of the breast, liver, uterus, prostate, and intestines; the latter, following epithelioma of mucous surfaces, in the palate, antrum, etc., or of a sinus following suppurative osteo-myelitis. In the latter case the disease develops at the orifice of the sinus, and spreads down to the bone.

The **Treatment** by operation must depend upon the extent of the disease and the condition of the patient.

CHAPTER XIII

INJURIES AND DISEASES OF JOINTS

Injuries: Contusions, wounds, sprains, dislocations—Diseases: Synovitis, arthritis, gonorrhœal affections, syphilitic affections, tubercular affections, arthritis deformans, gout, chronic rheumatism, hæmophilic joint, neuropathic arthritis, hysterical affections, tumours and cysts, loose bodies, affections of special joints.

INJURIES TO JOINTS

Injuries to joints comprise **contusions, strains, wounds,** and **traumatic dislocations.** Those inflammatory and diseased conditions, however, which are usually described as diseases of joints, owe their origin in many cases to traumatism, acting on a debilitated or specially predisposed person.

Probably in no other part of the body does predisposition to tuberculosis play such an important part in qualifying prognosis of injuries as in joints, for not only does the tubercle bacillus often choose a joint for the field of its operation, but strains, jars, and blows appear to be the very type of injury which produces the most favourable condition in that field for its attack.

Contusions.—Provided that the patient is healthy, a contusion to a joint is a simple injury. The violence may be **direct,** as when the patient falls on the shoulder or the great trochanter, or **indirect,** as when the hip-joint is contused by a fall upon the feet.

The bones are driven against one another, and the articular surfaces suffer ; the cartilage, underlying spongy bone, and synovial lining of the joint are all bruised, and this may cause an effusion of blood and serous fluid into the joint.

Signs and Symptoms.—Swelling and discoloration ; in superficial joints the former is marked, due to the effusion of blood (hæmarthrosis). The joint is held in the position of greatest ease, usually flexed. The presence of serous effusion may last for some time after the injury.

Treatment.—If seen at once, effusion may to some extent be prevented by pressure over the joint, applied by means of a firm bandage over a plentiful covering of cotton-wool ; massage and passive movement should be commenced almost at once in these cases. When effusion has already taken place, absorption may be promoted by treating the joint with evaporating lotions—lead and opium, or lead and spirit—for a few hours, and then applying pressure. When there is great effusion, some of the fluid may be withdrawn with an aspirating needle. Prolonged rest is to be avoided, and massage and passive movements may be commenced when heat and increasing swelling cease.

Penetrating Wounds.—The danger of wounds depends on whether the joint becomes septic. If an aseptic condition be maintained, the injury is not a serious one ; if, on the other hand, sepsis is admitted, acute inflammation occurs, and may lead to the total destruction of the joint.

Unless the wound is very small, there is usually an escape of synovial fluid, perhaps mixed with blood ; the synovia is recognized as a transparent fluid having the consistency of oil.

It is very important that such injuries should be carefully treated, and watch kept for any signs of septic poisoning. If the wound has been caused by a dirty instrument, or by a clean one passing through dirty skin, it is well to treat it as a septic one ; and, if very small, to enlarge it, and make sure whether the cavity of the joint has been opened.

After aseptic puncture of joints, even with considerable escape of fluid, there are no serious after-effects to be apprehended.

Sprains and Strains of Joints.—Sudden violence to a joint, usually indirect, often causes a rupture or stretching of some of the fibres of the ligaments. There is great pain, and hæmorrhage into the surrounding tissues or the cavity of the joint occurs. This takes some time to become absorbed, and the repair of the ligaments may be a slow process. In those who are predisposed to tuberculosis, the disease may be started by a strain, while in those who are weakly arthritis may be set up.

Unfortunately, after a bad strain a joint may become weak, leading to a repetition of the occurrence ; this is especially the case when a person uses the joint actively before a cure is established.

When a workman is injured in this way, the case may lead to a good deal of trouble, as it is very hard for a surgeon to state that a joint is perfectly cured if the patient persists in stating that there is pain on certain movements. Such cases lend themselves to malingering, and it is well to test a case very carefully before stating that a man is not fit for work. The malingerer usually states that no active nor passive movement gives pain except the particular one which he is called to make at his work ; such a statement may be received with suspicion.

It should always be borne in mind that there may be remote effects of strain leading to disease of the joint.

Symptoms.—There is great pain, which may last for some time, and is increased on moving the joint, but often passes off if the movements are continued. The effusion of blood and serum occasions swelling and discoloration, and if it has taken place into tendon sheaths, it often gives rise to a creaking sensation.

Diagnosis.—From fracture and dislocation the injury is distinguished by the bony points maintaining their normal relationship. Tenderness over the affected tendons often distinguishes it from fracture. When the effusion is great, it is wise to clear up the diagnosis by having an X-ray photograph of the joint taken.

Treatment.—The joint should be douched with hot and cold water, after which it is anointed with olive oil and gentle massage carried out for about ten minutes. The joint is then enveloped in thick layers of cotton-wool, and a firm bandage applied ; the limb is then placed at rest. Massage is to be repeated twice daily, and carried out for a quarter of an hour. In addition, active and passive movements

are to be adopted, and in the intervals of treatment the patient is told to carry out the movements of the joint which do not cause actual pain. When swelling and heat have disappeared, the joint should be strapped, and the patient should get about, being careful that he does not strain the joint.

Strapping of the joint may be carried out at once, but the results are not generally so good as when the above treatment is adopted.

Traumatic Dislocations.—The most usual sufferers from this form of injury are adult males. In young persons separation of the epiphysis is more likely to occur, and in the old violence will probably produce fracture rather than dislocation. Such an accident is sometimes favoured by the anatomical arrangement of the part; thus, a bony cavity may be so shallow that the head of the long bone of the articulation rests on rather than in it, or there may be some weakness of the muscles and ligaments of the part.

Articulations may be strong and not liable to dislocations, owing to their bony arrangement, as in the hip-joint, or owing to their muscular and tendinous attachments, as in the knee-joint.

The exciting causes of dislocation are direct or indirect violence, and the action of muscular force. External violence is more usually indirect, applied at some distance from the joint, as in dislocations of the shoulder-joint, from falls upon the hand. Muscular action producing dislocation is not common in joints in which the head of the long bone is deeply sunk in its cavity, or in those in which the bones interlock, but occurs where strong muscles are attached near articulations of a shallow kind; dislocations of the jaw and patella are examples: after dislocation of a joint, however, muscular force may be sufficient to reproduce the displacement.

Various forms of dislocation are described as—

Complete Dislocation (luxation), in which the articulating surfaces are displaced from one another.

Incomplete Dislocation (subluxation), in which the surfaces are separated from one another.

Compound Dislocation, in which there is a wound of the skin communicating with the dislocation.

Complicated Dislocation, where the accident is associated with injury to viscera, vessels, or nerves.

Fracture Dislocation, in which there is coexisting fracture of the bone in the neighbourhood of the joint.

Signs and Symptoms of Dislocation.—There is the history of an accident. Locally there is pain, and evidence, as a rule, of bruising. There may be considerable swelling of the part, caused by extravasation into the lacerated tissues. Deformity of the limb exists, caused by the displacement of the articulation, and the end of the bone can often be felt occupying an abnormal position. The bony landmarks lose their normal relationship. The deformity can often be plainly seen, and a diagnosis arrived at by the eye alone, especially if the sound limb is compared with the injured one. There is restricted movement and loss of function of the part; these are usually very marked. The surgeon should be careful not to mistake the mobility caused by a fracture near the joint for that of the joint itself; of course, pain will be marked when movement is attempted with fracture present, but this may be thought to be due to the bruising of the part or to the dislocation, if the latter be detected.

Effects of Dislocation.—It is the duty of a surgeon, in treating a case of dislocation, not merely to reduce it, but also to consider what may be the effects of the injury, and for what period disability may last. This is specially mentioned here because a dislocation is unlike a fracture or severe injury to the soft tissues, where a patient's disability is obvious. To the lay mind, at any rate, it may appear that once a dislocated bone is replaced the injury is repaired, and the patient may return to his work. The dangers of his doing so are owing to the fact that very often, in the production of the dislocation, injury has been done to one or more structures entering into the formation of the joint or placed close to it. Thus the articular surfaces or the neighbouring portion of bone may be fractured. The ligaments and muscles of the joint will certainly be strained and weakened, and will allow the displacement to recur should the patient attempt muscular work at once after reduction. Nerves and vessels situated in the vicinity of the joint may also be injured either by the violence which caused the dislocation, or by pressure from the displaced bone, and this injury may lead to loss of function of some particular group of muscles or to aneurism. There will also be a considerable effusion of blood from the lacerated tissues, giving rise to local pain, and pressure symptoms. This effusion will take some time to become absorbed.

It sometimes happens that a patient does not seek advice for a dislocation till the setting up of late symptoms draws his attention to the matter, and occasionally a dislocation is not recognized. From whatever cause arising, an unreduced dislocation is a serious matter. The non-seeking of treatment in many cases is due to the person being unaware that there is a dislocation until told by the doctor he consults for some attendant symptom. What happens in some cases is, that the dislocation has been reduced, and, recurring with less pain and shock than when first injured, the patient attributes the symptoms felt to the first dislocation, and so takes no further steps.

The results of non-reduction are that the articular cavity becomes more or less filled up, and the displaced head of the bone makes for itself a new bed amid the surrounding tissues, or on another bone, and may thus produce pressure symptoms, while the muscles and tendons become altered in length to accommodate themselves to the new condition of things. The function of the limb may thus be seriously interfered with, and deformity produced, which, if of long standing, will be hard, if not impossible, to rectify.

General Treatment.—Reduction should be carried out at once, if possible, by making the bone retravel the same route through the tear in the capsule. The manipulations will vary with different joints, and with different forms of dislocation of the same joint.

Reduction is made difficult by the muscular action on the displaced bone, by the intervention of tendons and ligaments, and by a small, perhaps valvular, opening in the capsule.

In many cases which are difficult of reduction it is better to give a general anæsthetic than to use violence and cause great pain. This is specially true in muscular subjects, where the muscles act powerfully to retain the bone in its abnormal position. The muscles may, however, be tired out by making steady, prolonged traction on the limb, while counter-extension is made on the proximal side.

When the joint is in position, it should be fixed by bandages to avoid recurrence of the dislocation. Early massage and passive

movements should be carried out, and active movements may be attempted after a few days. In some cases it is found impossible to reduce the bone, and operative measures have to be undertaken.

When the dislocation is compound, it is usually the result of great violence, and may be complicated by fracture or laceration of muscles, vessels, and nerves. Sepsis is, of course, the great danger, and if it occurs a stiff joint may result. Amputation is sometimes called for in these dislocations. When this is not required by the condition of the parts, the wound, and all parts concerned, should be rendered aseptic, the dislocation is then reduced, and drainage allowed for in a corner of the wound, the rest being closed.

When fracture complicates dislocation, the dislocation is first reduced, and then the fracture, though it is advisable to fix temporary splints over the fracture before reducing the dislocation. It may be necessary to wire the former in order to be able to carry out early movements of the joint. The most common dislocation with fracture is that of the shoulder with fracture of the neck of the humerus. Lateral dislocation of the ankle is uncommon, but when met with is practically always accompanied by fracture.

In an old-standing dislocation, when the injury has been overlooked or the reduction not successful, replacement by manipulation is difficult, if not impossible. The dangers are, rupture of vessels, injury to nerves, fracture of the bone, and tearing of the soft parts. Operation may be called for to reduce the dislocation, to make a new socket, or to excise the head of the bone.

Pathological Dislocations.—These are associated with diseased conditions of the joints, such as tuberculosis, deformities, or with suppurative processes following certain infective diseases, such as typhoid, scarlet fever, and diphtheria, which tend to weaken and stretch the ligaments.

Congenital Dislocations.—These are probably the result of arrested or abnormal development during fœtal life, or of dislocations *in utero*. (See Deformities, Chapter XIV.)

SPECIAL DISLOCATIONS.

While displacement of any articulation may occur, that of the shoulder is by far the most common; dislocation of the hip the most serious, that of the semilunar cartilages probably the most painful, and displacement of the ankle the most likely to be associated with fracture.

Lower Jaw.—The direction of this dislocation is usually forwards; it may be unilateral or bilateral. The latter is much the more common, is met with generally in middle life, and in females rather than males.

The **Cause** of the displacement may be, and usually is, very simple, such as yawning, taking a large bite, or the clumsy insertion of a mouth gag.

Signs and Symptoms.—The mouth cannot be shut, and the chin is shot forwards, the lower teeth projecting beyond the upper; in unilateral cases the chin is displaced to one side. A depression is detected in front of the ear, and before this is a prominence formed by the condyle.

Treatment.—Pressure downwards and backwards on the lower molar teeth by the protected thumbs, while the fingers grasp the jaw

outside and carry the chin upwards as soon as the condyles have cleared the articular eminence.

Clavicle.—The **Sternal** end may be displaced **forwards,** so that the bone comes to lie on the manubrium sterni ; **backwards,** giving rise to symptoms of pressure on the trachea, gullet, and great vessels ; **upwards,** a very rare form of displacement.

Treatment.—The shoulders should be drawn backwards and fixed by a figure-of-eight bandage.

The **Acromial** end may be displaced upwards or downwards. The reduction is easy, but the dislocation is very liable to recur. A bandage should be passed over the shoulder, and under the flexed elbow, while the forearm is carried in a sling. If the dislocation cannot be kept reduced, an open operation may be carried out to fix it, but it is not of any great moment if it remains unreduced.

Dislocation of the Shoulder.

This dislocation is estimated to occur as frequently as all other dislocations together. This is owing to several reasons—the relative largeness of the head to the cavity into which it is received, the very lax capsule, the large range and force of the movements of the joint, and its exposed position. The violence causing the dislocation may be direct or indirect, more usually the latter, through falls upon the elbow or hand when the arm is extended ; the weakest point of the capsule is at its lower and inner part; this receives the full force of the violence, and the head of the humerus is displaced into the axilla. This is called the **subglenoid** dislocation ; the other varieties may be secondary to this, from the direction of the initial force. They are **subcoracoid, subclavicular,** and **subspinous,** the subcoracoid being most frequently met with, as to that position, the bone travels from the subglenoid.

Signs.—The various varieties will present some little divergence from the general signs, which are as follows :

Both shoulders should be looked at and compared, and it should be remembered that both may look exactly similar and at the same time be abnormal ; this is due to bilateral dislocation being present, a quite possible accident.

The shoulder looks flat, owing to the head of the humerus being absent from its normal position and displaced inwards; the acromion process is abnormally prominent. The upper part of the arm appears to be very close to the chest wall, while the elbow protrudes and the patient is unable to make it touch the wall of the chest while he places his hand upon the uninjured shoulder (Dugass's sign). The head of the bone may be felt in the axilla or some other abnormal position. The axillary measurement is increased. There is loss of almost all the normal movement of the joint, and there may be considerable local bruising and swelling.

Fracture of the anatomical or surgical necks of the humerus should be carefully excluded. If this has been done, and yet, on reduction, crepitus felt, and the bone slips easily out of position again, it is probable that fracture of the glenoid cavity complicates the injury.

It should be remembered that dislocation of the shoulder, uncomplicated by the accident, may become so by treatment, owing to some of the bloodvessels or large nerve trunks in the vicinity being injured

during reduction. When a dislocation has been reduced immediately after the injury, it is a difficult matter to determine when such injury was received.

Special Signs—*Subglenoid.*—The head is felt in the axilla, and consequently there are symptoms of pressure on the vessels and nerves. There is about 1 inch lengthening in the measurement from the acromion process to the external condyle of the humerus. The elbow is fixed, owing to tension on the biceps muscle.

Subcoracoid.—The head may be felt below the outer end of the clavicle, and the elbow is held outwards and backwards. There is little or no shortening. Dugass's sign may be absent.

Subclavicular.—The head is below the middle of the clavicle, the elbow is held away from the side, and there is slight shortening.

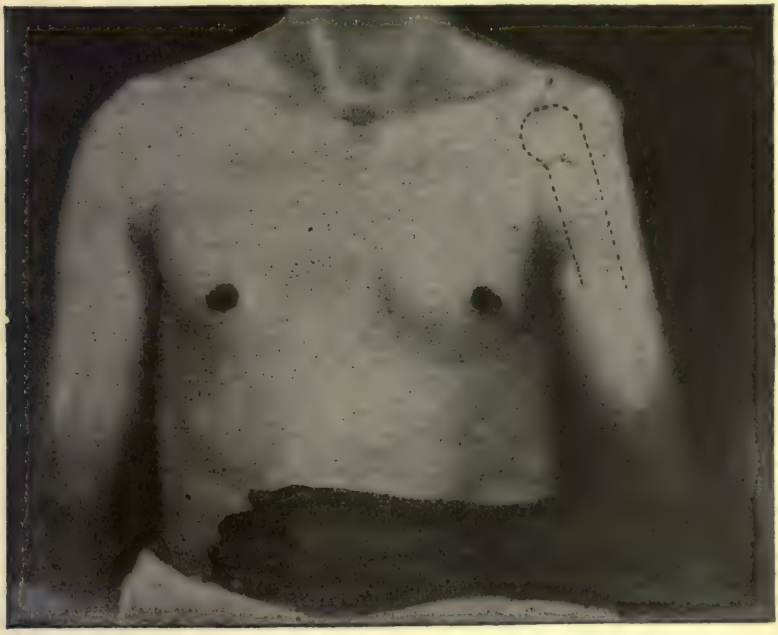

Fig. 32.—Subcoracoid Dislocation of the Shoulder.
(Stewart's "Surgery.")

Subspinous.—The head of the bone is below the acromion process, the elbow is carried forward, and the arm rotated inwards.

Treatment.—*Manipulation*, with or without an anæsthetic.

Kocher's Method.—(1) The elbow is held to the side and the forearm flexed to a right angle. (2) The hand is swung forwards and outwards in order to rotate the humerus outwards and to relax the external rotators. (3) The elbow is carried across the body towards the mid-line in order to relax the upper margins of the gap in the capsule. (4) The elbow is raised in order to further relax the upper margin of the gap in the capsule, the lower being tense. (5) The palm of the hand is moved towards the sound shoulder, thus rotating the humerus inwards, in order to make the head of the humerus slip into the capsule. (6) The elbow is lowered. (5) and (6) should be done smartly.

Extension.—This is exerted—(1) By pulling on the hand outwards and then downwards by an assistant, while the surgeon manipulates the head of the bone into position. (2) By the surgeon pulling on the hand, while his heel exerts counter-extension in the axilla. (3) By pulling on the hand by one assistant, while the second exerts counter-extension with a jack towel round the chest, and the surgeon manipulates the bone into place.

Hyperabduction.—In certain recent cases this method is admirable. The patient lying on a mattress or flat couch, the scapula being fixed, the arm is raised slowly from the side in the extended position to above the head. The bone may slip in of its own accord or by manipulation in the axilla.

Having reduced the dislocation, a layer of wool is put into the axilla, the arm bandaged to the side, and the forearm supported in a sling. Massage and passive movements, except in the direction of abduction, should be carried out daily. All movements may be carried out, and the bandage dispensed with at the end of a week, and active movements can be commenced at the end of four weeks.

Dislocation of the Elbow.

This joint may be displaced backwards, forwards, or laterally.

Backwards.—This is the common form, and frequently met with in children. The radius and ulna are driven backwards, frequently by a fall on the outstretched hand. The coronoid process may be, and often is, broken, or is displaced behind the humerus. The deformity is characteristic, the olecranon process forming a marked prominence on the back of the elbow, while the lower end of the humerus lies in the bend of the elbow with the biceps tendon stretched over it. The elbow remains flexed, and any attempt to move it causes great pain. The measurement from the external condyle to the tip of the styloid process of the radius is shortened by about an inch.

The injury is to be distinguished from supracondylar fracture of the humerus with backward displacement of the lower fragment and from separation of the lower epiphysis of the humerus.

Forward Dislocation.—This is rare, except as a complication of fracture of the olecranon. The forearm is lengthened, the condyles prominent, and the olecranon obscured or absent from its normal position. When the process is not fractured by the violence which causes the dislocation, it comes to rest below the condyles, forming an incomplete dislocation.

Lateral Dislocations.—These are very rare. The inward one is always incomplete as a rule ; but complete separation may take place. The common cause of these dislocations is a fall on the outstretched hand, when the forearm is pronated. The limb is flexed and pronated, and the bony points are easily felt in their abnormal position.

Treatment.—The surgeon should hold the humerus and the wrist, and place his knee on the bend of the elbow. The limb is fully extended to relax the triceps muscle and free the coronoid process ; traction is then made on the forearm and arm in opposite directions, while the operator's knee presses the lower end of the humerus backward. The joint is then slowly flexed, and as a rule slips into position. If adhesions be present, they should be broken down under an anæsthetic. After reduction, the limb is fixed in a rectangular splint.

Early massage should be carried out, and the splint can be usually left off at the end of a week.

When the coronoid process is broken, dislocation is apt to recur. Fixation should therefore be adopted, the limb being kept up at an acute angle. Massage should be begun in a day or two, but no movements be permitted for a fortnight.

When the dislocation is forward, it is reduced by flexing the elbow fully, or pushing the bones of the forearm backward with the knee while the humerus is pulled forward.

Dislocation of the Ulna.—This is a very rare accident. If present, it is usually backwards and associated with fracture of internal condyle. Its reduction is not a matter of difficulty.

Dislocation of the Radius.—This may be completely forwards, which is the usual form, completely backwards, or outwards, or it may be incomplete, which is termed "subluxation of the head of the radius."

Forward Dislocation.—There is prominence of the head of the bone in front of the elbow or in the hollow behind the external condyle. The elbow cannot be completely flexed, and supination is imperfect, the limb being held half flexed or pronated. This injury may be caused by a blow on the back of the upper end of the radius. In children it may result from a sharp pull on the forearm or hand when the arm is pronated.

In a few cases the displacement is backwards or outwards. The dislocation is easy to reduce, but it frequently recurs owing to rupture of the orbicular ligament.

Treatment.—The forearm is alternately flexed and extended, while traction is exerted from the wrist, an assistant meantime pressing the head of the radius backwards. A pad is placed in the bend of the elbow, and the arm fixed in the flexed position. Dislocation of the radius frequently accompanies fracture of the upper third of the ulna.

Subluxation of the Head of the Radius.—This is sometimes called **"pulled elbow,"** and is a fairly common injury in children, brought about by lifting or dragging them by the hand or forearm, the result being to cause the front part of the head of the radius to come out of the orbicular ligament. There is pain in the region of the elbow, and the arm becomes useless, being held flexed midway between pronation and supination. The head of the radius appears unduly prominent.

Treatment.—Occasionally the condition rights itself; at other times it is necessary to replace the head of the bone by flexing the elbow, and then exerting slight traction on the forearm and alternately supinating and pronating it.

Dislocation of the Wrist.—Dislocations of the wrist are very uncommon, the backward one being the least rare.

The carpus is displaced backwards; both styloid processes project prominently, their relationship to one another remaining normal. The carpal bones form a swelling at the back of the wrist, and their relationship to the styloid processes is abnormal. The ends of the radius and ulna form a smaller swelling at the front of the wrist.

The deformity produced is somewhat similar to that of Colles's fracture, but the projections are lower down and the styloid processes retain their relationship to one another.

Treatment.—Reduction is effected by making traction on the hand while the carpus is pushed into position and retained by a splint, which should be removed daily to admit of massage.

Various other dislocations occur about the wrist, such as **inferior radio-ulnar dislocation,** those of the **carpal bones** and **carpo-metacarpal joints,** but for the most part they are rare or occur as complications of fractures.

Of the carpal dislocations, the one most commonly met with is displacement of the head of the **os magnum,** from the scaphoid and semilunar bones. When the hand is fully flexed, the displaced head of the bone makes a prominence on the dorsal surface opposite the base of the third metacarpal. It may be necessary to excise the bone, but an effort should be made to return it to its place and to keep it there by fixing the hand in a dorsiflexed position for about a week.

Of the carpo-metacarpal dislocations, the commonest direction is backwards, and the metacarpal bone most likely to be affected is that of the thumb.

Thompson and Miles state that there is good reason to believe that the injury commonly described as " incomplete dislocation " or " subluxation of the metacarpal of the thumb backwards," is really a fracture of the base of the bone—an injury now known as " Bennett's fracture."

Dislocation of the First Phalanx of the Thumb.—This is usually a **backward** displacement of the phalanx, brought about by extreme extension of the thumb. The head of the metacarpal bone passes between the two heads of the flexor brevis pollicis and presses the tendon of the long flexor to the ulnar side. The head of the bone forms a prominence on the front of the thumb.

Great difficulty is often experienced in reducing this dislocation, due to the intervention of the glenoid ligament (capsule of the joint) and the sesamoid bones between the head of the phalanx and the metacarpal bone, and to a lesser extent the holding of the head by the long flexor tendons and the short muscles.

Treatment.—Reduction may often be effected by manipulation. Flex the metacarpal bone and overextend the phalanx, and push it upwards to try and carry it over the head of the metacarpal, then exert traction and flex the joint. The last two movements may be tried by themselves.

If these manipulations fail, the joint is opened behind, subcutaneously or openly, and the glenoid ligament divided.

Dislocation of the Ribs.—At the spinal attachment is generally associated with fracture of the vertebræ. Dislocation of costal cartilages may occur at the sternal end.

Dislocation of the Hip.

This is not a common accident owing to the strength of the joint, both from the deep socket of the articulation and the muscles and ligaments around it. The violence which produces the displacement is always indirect. In those past middle life the force of the injury produces fracture of the neck of the femur rather than dislocation. The displacement occurs by falling from a height with the legs separated, by forcibly separating the limbs, or by accidents applying

violence to the feet or knees when the limb is in a position of abduction, this being the most common position. The ligamentum teres is invariably torn, the Y-shaped ligament seldom.

The position assumed by the displaced head of the bone will depend on the direction of the violence or subsequent movements by the patient or his friends. The head may travel forwards and produce the **pubic** or the **obturator** variety, when the limb will be rotated outwards and extended; or it may pass backwards and come to rest on the **dorsum ilii,** or near the **ischiatic notch**, when the limb will be flexed and rotated inwards. The latter is much the more common direction.

In **diagnosing** a dorsal dislocation of the hip, care should be exercised to exclude impacted extracapsular fracture; this is best done by noting the abnormally placed head of the femur, the absence of any increased breadth of the trochanter, and the position of adduction and inversion. The forward displacements are distinguished from the backward by the limb being abducted and everted, both more marked in the pubic than in the obturator displacement; and in the former there is shortening of the limb, while in the latter there is lengthening. In the pubic displacement there is some risk of injury to the vessels from pressure by the head of the bone, and pain is sometimes felt owing to the anterior crural nerve being pressed upon.

When promptly and efficiently treated, dislocation of the hip, while always a serious accident, need not lead to any bad remote consequences, if uncomplicated by fracture of the acetabulum or injury to vessels; nor is there any great risk, on account of the arrangeme nt of the joint that the accident will recur, so long as the limb has been kept at rest for a considerable time—at least fourteen days after the accident—and no active movements permitted for some further period. Predisposition to tuberculosis may lead to the production of hip-joint disease following the accident.

Backward Dislocations—(*a*) **Dorsal Displacement.**—The head of the bone comes to lie on the **dorsum ilii (iliac dislocation)**, and can usually be felt through the buttock. In many cases the obturator internus muscle is ruptured, or the head of the bone lies **above** the tendon, and the short rotators may be lacerated. The great trochanter is above Nélaton's line and nearer to the anterior superior iliac spine. The ilio-tibial band is relaxed. The deformity produced is as follows: The leg is shortened by about two inches; it is flexed, adducted, and inverted; the femur crosses the lower third of the opposite bone; while the great toe rests on the instep of the opposite foot. There is a hollow in Scarpa's triangle.

(*b*) **Dislocation into the Ischiatic Notch.**—The displacement is somewhat similar to the last, but differs from it in that the tendon of the obturator internus remains intact, and, lying **over** the neck of the femur, bends it down, so that shortening is less—usually under an inch. The femur crosses the knee of the opposite side, and the ball of the great toe rests on the dorsum of its fellow.

Forward Dislocation—(*a*) **Dislocation into Obturator Foramen.**—The head of the femur lies in the foramen on the external obturator muscle, with its articular surface looking forwards, and may be felt in the perineum. The adductor muscles may be lacerated, the ilio-tibial band is tense; the capsule is torn at its lower part; the trochanter is obscured, and looks backwards. The body is bent forwards to relax the ilio-psoas muscle.

The deformity produced is as follows : The leg is **apparently lengthened,** owing to the tilting forward of the pelvis ; there is flexion, abduction, and outward rotation. The toes point forward, and the heel is drawn up.

(*b*) **Pubic Dislocation.**—This is a further degree of the last dislocation. The capsule is torn further forwards. The deformity differs from the last in that the leg is shortened about one inch. The head of the bone may be felt under Poupart's ligament ; abduction and eversion are more marked, while the toes point outwards rather than forwards.

Treatment.—For the reduction of dislocations of the hip, full anæsthesia is as a rule required. The essential indication is to relax

FIG. 33.—HIGH DORSAL DISLOCATION OF THE HIP.
(Stewart's "Surgery.")

the ilio-femoral ligament. Traction methods on the extended limb seldom do much good, since the hip requires to be well flexed to relax the Y-shaped ligament.

For backward dislocations : Flex the knee and the thigh in the adducted position ; then fully abduct the thigh, and at the same time externally rotate it, to make the head of the bone retrace its way to the rupture in the capsule and to relax the rotator muscle. The leg is then brought down smartly to make the head of the bone re-enter its socket.

These movements are sometimes summed up in the direction "Lift up, bend out, roll out."

For forward dislocations : The thigh is flexed in the abducted position. The limb is then adducted and rotated inwards, and finally smartly extended. These movements are summed up in the direction, "Lift up, bend in, roll in."

Dislocation of the Patella.

The patella may be dislocated outwards—this is the least rare—inwards, or vertically, the bone being rotated so that its edge rests on the front of the femur.

Certain deformities, as genu valgum or varum, predispose to the accident, which may be produced by muscular or by direct violence. It is usually accompanied by some rupture of the quadriceps aponeurosis.

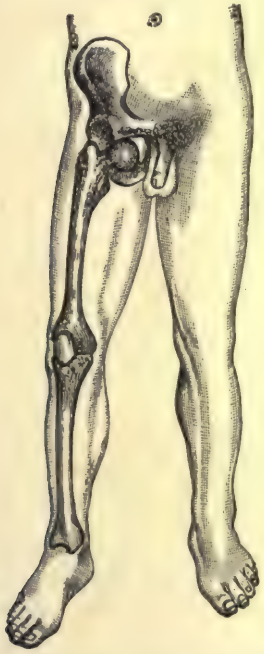

Fig. 34.—Dislocation of Hip into Obturator Foramen.
(Stewart's "Surgery.")

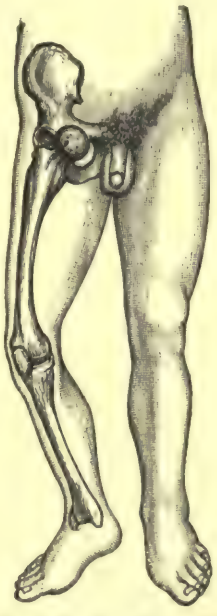

Fig. 35.—Pubic Dislocation of the Hip.
(Stewart's "Surgery.")

Treatment.—Reduce by flexing the thigh and extending the knee, at the same time pressing the bone into position. The limb should be put upon a back splint, and firm pressure applied to the front of the joint to check effusion. The patient may require to wear a knee-cap, as the dislocation is liable to recur frequently.

Dislocation of the Knee.

The knee may be dislocated forwards, backwards, or in a lateral direction. It is usually incomplete, and produced by some extreme degree of violence of a twisting character. The condition is rare. The

chief complication which may happen is rupture of or pressure on the popliteal vessels, possibly leading to gangrene.

The forward dislocation is least rare, and results from sudden extreme extension of the knee; the tibia passes forward, and the condyles of the femur may be felt behind.

The backward dislocation is usually due to direct violence driving the tibia backwards or the femur forwards. The leg remains in the hyperextended position, the head of the tibia being in the popliteal space.

The lateral dislocations are incomplete, and may be mistaken for separation of the lower epiphysis of the femur.

Treatment.—Traction and counter-traction are usually sufficient to restore the joint to its normal position, after which it will be required to be kept in the flexed position for a time. After reduction of the lateral varieties splints should be worn for a few days. Massage is begun early in all varieties.

The Superior Tibio-Fibular Articulation may be dislocated by twisting violence applied to foot or leg. The patient is unable to walk on account of the pain, but the movements of the knee are quite free. The dislocation is reduced by applying pressure over the fibula with the knee flexed. It should be kept in position by a few turns of a plaster of Paris bandage.

Displacement of the Semilunar Cartilage.—This accident is by no means uncommon, and is due to strains or sprains of the joint. Any sudden jerk when the knee is bent, or violent rotation of the body while standing on one leg, may cause the accident. Some persons seem to be more liable to it than others, and when it has once occurred it is liable to happen over and over again, the person acquiring the "habit." The internal cartilage is much more frequently affected than the external.

The **Symptoms** are sudden **intense** pain. There is inability to extend the knee, which remains locked in a position of flexion. Replacement may occur spontaneously with a sudden "snap." Synovitis is an almost constant accompaniment of the accident. The remote results when the displacement repeatedly occurs are a chronic synovitis, a weakening of power and usefulness in the limb, and pain in the knee. These may seriously interfere with a patient in the discharge of his duties. Operative procedure is necessary in all recurrent cases before the limb is completely useful again.

Treatment.—The cartilage may be replaced by flexion, followed by outward rotation, abduction, and sudden extension of the joint. In recent cases, when occurring for the first time, the joint should be placed in splints for some weeks, massage and movements being employed after the first few days. In recurrent cases a retentive apparatus, which embraces the joint, allowing flexion, but not rotation, may be worn, or operative procedure may be undertaken.

Operation is desirable in all recurrent cases in a young, active man. A semilunar incision is made over the inner side of the joint, which is opened, and the cartilage removed, or as much of it as is damaged or loose. The joint is then closed and the skin stitched over it.

Loose Bodies.—These may be mistaken for displaced semilunar cartilage. In the case of a loose body pain is not so long continued, locking of the joint does not occur, and effusion is not so great.

If the **synovial fringe** be nipped in the joint, the thickened membrane

may be felt, and there may be signs of chronic synovitis. The diagnosis is often difficult as between these conditions, but that is not of great moment, as the joint has usually to be opened.

Dislocation of the Ankle-Joint.

This joint is a strong one, and dislocations are not common. They may be due to direct or indirect violence. Owing to the arrangement of the joint, the displacement is usually associated with fracture of some of the bones entering into the articulation.

The direction of the dislocation may be **lateral.** These are more accurately described as fracture-dislocations—**backwards, forwards,** or **upwards.**

The symptoms are sufficiently obvious, and will vary according to the direction of the dislocation. The X rays should always be employed in these cases to give an accurate diagnosis.

The injury is a serious one, and efficient treatment is needed to insure subsequent freedom from pain and stiffness.

Backward Dislocation is the most common, and is caused usually by great plantar flexion, or by falling backwards when the foot is fixed. The lateral ligaments are ruptured, and the malleoli may be fractured. The foot looks short, the heel projects behind, and the lower ends of the leg bones project in front.

Forward Dislocation results usually from violent flexion of the foot. The foot looks long, and the heel is not as prominent as normal, while the hollows on each side of the tendo Achillis disappear. The malleoli are behind and near the sole, and the astragalus is felt in front of the tibia.

In **Upward Dislocation** the astragalus is driven up between the leg bones, producing a great broadening of the ankle.

Treatment.—Under an anæsthetic, the foot is extended while the knee and hip are flexed. Traction is exerted on the foot, and counter-traction upon the leg, and the bones manipulated into their proper place. The tendo Achillis may require division before reduction can be accomplished, particularly in forward dislocation. The ankle should be kept at rest between sandbags, and massage carried out from the first.

Dislocation of the Astragalus.

The bone may be dislocated from the bones of the leg above and from the os calcis and scaphoid below. The usual displacement is **forwards** and **outwards,** but it may be **backwards** and **inwards,** and **lateral (dislocation by rotation),** in which the bone is rotated in its socket.

Signs.—The astragalus is felt on the dorsum of the foot, or above the heel, in backward dislocations. The distance of the malleoli from the sole is lessened, but their relation to the back of the heel and the toes is unaltered.

Treatment.—Reduction of the dislocation under an anæsthetic with the knee flexed. If this fails, open operation must be undertaken, and the bone replaced or removed.

Subastragaloid Dislocation (Astragalo-Calcanean Joint).

The direction may be backwards, which is most common, backwards and inwards, or backwards and outwards.

Signs of Backward Displacement.—The head of the astragalus is felt and seen on the dorsum of the foot. The distance from the malleoli to the heel is increased, to the toes decreased. The foot is plantar flexed and inverted or everted.

Treatment.—Reduction under anæsthesia, if possible; otherwise open operation to remove the tendons of tibial muscles from the neck of the bone, or to remove the bone.

Pure dislocations of the remaining parts of the foot are very rare, except dislocation of the **great toe** at the metatarso-phalangeal joint. In it the base of the proximal phalanx passes up to the dorsum of the foot. The diagnosis is obvious, and the joint may be reduced by traction and pressure.

DISEASES OF JOINTS

SYNOVITIS.

Synovitis is an inflammation of the synovial membrane lining a joint, frequently due to injury, but also arising from constitutional diseases, such as syphilis, gonorrhœa, gout, or rheumatism, or from pyæmia.

In traumatic synovitis there is an inflammation of the synovial membrane, followed by exudation of plasma and leucocytes into the substance of the membrane. This exudation eventually enters into the joint; the effusion is frequently mixed with blood. If coagulation take place, the lymph deposited on the articular surfaces may fail to become absorbed, and, instead, be organized, producing adhesions. This and relaxation of the ligaments of the joint by the inflammation should be remembered as possible remote results following synovitis.

Acute Synovitis.—The **Signs of Acute Synovitis** are pain, with distension of the joint and local heat, redness and hyperæmia. It is found that the limb is held in a stiff position of semiflexion to insure ease by giving the greatest room for the effusion. It is possible that such a position may become chronic if efficient treatment is not carried out.

In the **Shoulder** the effusion is evidenced by a swelling at the anterior border of the deltoid, extending sometimes to the axilla; the pain is increased by pressing the head of the humerus into the glenoid cavity.

In the **Elbow** the hollows on either side the olecranon are filled out by soft swellings.

In the **Wrist** there is a general puffiness, back and front, which is strictly limited to the joint, and does not crepitate on pressure.

In the **Hip** there is a tender swelling in the superior and external portion of Scarpa's triangle.

In the **Knee** the hollows on both sides of the patella and its ligament disappear, giving to the knee a globular outline; the subcrural pouch

is also distended, constituting a swelling which extends some inches above the patella, and is more marked on the inner side. The patella is felt superficially resting on a cushion of fluid—**riding** of the patella—which serves to distinguish the condition from inflammation of the bursa patella, in which the fluid is superficial to the bone.

In the **Ankle** the hollows between the tendo Achillis and the malleoli are replaced by puffy swellings; there is also some swelling in front of each malleolus.

Diagnosis.—It must be clearly borne in mind that synovitis is frequently merely a symptom of some grave trouble present, or to be present, in the knee-joint.

When secondary to **arthritis,** there is pain and swelling of the ends of the bones, and grating may indicate destruction of cartilage.

In **tuberculous disease** the injury may be very trivial, as opposed to the violent injury necessary to produce simple traumatic synovitis in a healthy joint; while the onset is slow, inflammation and pain are often absent, and the swelling has a puffy rather than a fluid feeling. The history of injury, if given, is of one received some time before the swelling was noticed.

When swelling is due to **hæmophilia,** there is a sudden onset following a **trivial** injury, little pain, and a history of the constitutional condition.

Treatment.—This will be modified according to causation, but the following is a general outline, and particularly applicable to cases of pure traumatic origin:

The joint should be immobilized so long as the inflammation is acute and the effusion increasing, and bandaged firmly over a thick layer of cotton-wool. It is often desirable to aid absorption by applying evaporating lotions in the early stages, and hot fomentations to relieve pain after the first day. Belladonna and glycerine often proves a useful application. As soon as the inflammation has ceased and the effusion no longer increases, massage and passive movements should be carried out, while active movements are begun when they no longer cause pain. If adhesions form, they should be treated by extension in the acute or subacute stage, and be broken down under an anæsthetic later on.

Rheumatic Synovitis.—This condition may arise in the course of acute rheumatism, in which case there is no difficulty in diagnosis.

It may, however, be a chronic affection from the start. This form is characterized by swelling of one or more joints, due to effusion and thickening of the synovial membrane and of the ligaments. This may go on to produce fixity of the joint by ligamentous changes, and the development of intra-articular adhesions.

If an injury has been received to any particular joint and these changes take place, the position of the accident as a causative agent has to be defined. The fact that the condition is rheumatic may be ascertained by the presence of other evidences of rheumatism, as chorea, erythema, and rheumatic nodes, while usually more than one joint is affected, and there will probably be a rheumatic history. If these facts and symptoms can be elicited, the accident may be relegated to a very subsidiary position as the cause, either direct or indirect.

In the course of acute rheumatism one joint after another becomes affected, usually as a synovitis. There is intense pain, high fever, and profuse sweating. The condition yields to antirheumatic treatment.

Chronic Synovitis (Hydrops, Hydrarthrosis).—The condition may be chronic from the beginning, caused by old-standing irritation, or may follow an acute attack, and be accompanied by slight or profuse effusion (serous synovitis); in the latter variety the bursæ become distended also. The symptoms of chronic synovitis as distinguished from acute may be summed up in the words, **Less pain, more weakness.**

The **Prognosis** is not very good, as troublesome adhesions often form, while overgrowth of the synovial fringes may take place, giving rise to enlarged villi, which may be caught between the bones and cause great pain and increased inflammation. There are, however, many cases which do well under suitable treatment.

Diagnosis has to be made between simple chronic synovitis and other conditions giving rise to effusion into the joint.

In **osteo-arthritis** there are usually several joints affected; there is lipping of the cartilage, and the condition of the ends of the bone produces grating.

In **Charcot's disease** the onset is more sudden, and there are co-existing nerve lesions.

In **tuberculous disease** no definite cause can be discovered; the effusion is usually less in amount, and the muscles are more or less wasted.

In **venereal disease** the history and effect of treatment will point to the condition present.

Treatment.—The joint should be fixed, and counter-irritation by means of blisters applied. If this fails, massage and hot-air baths may be tried, frequently with good effect. Some of the fluid may be removed by aspiration, and pressure and rest carried out afterwards. If all other methods fail, the joint may be opened under strict aseptic precautions, and any cause of irritation, such as a foreign body or synovial fringe, removed.

Chronic Rheumatic and Syphilitic Synovitis, leading sometimes to arthritis, may be lighted up by accidental injury as an exciting cause in those who are the subjects of either disease.

INFLAMMATORY JOINT DISEASES.

Acute Arthritis.—In this affection the entire joint is involved in the inflammation.

It is due to the entrance of a micro-organism; this may take place from within, or rarely from without, owing to traumatism. The organism usually present is the *Streptococcus articulorum*, which is a modification of the *Streptococcus pyogenes*.

The **Signs** and **Symptoms** are intense pain with great tenderness, accompanied by redness, heat, swelling of the joint, and high temperature. There is wasting of muscles, especially of extensor muscles, but they do not show the reaction of degeneration. The joint is distended with fluid, which soon becomes purulent; the limb is placed in the semiflexed position and fixed there by the muscles. The pus bursts through the capsule, and either burrows amongst the muscles of the limbs or goes direct to the surface. As the articular surfaces become affected, there is an intensely painful starting at night, due to the ulcerated cartilage surfaces coming together owing to muscular relaxation as the patient drops asleep. The joint becomes gradually

PLATE XXX.

INFECTIVE ARTHRITIS.

First metacarpal phalangeal joint alone involved, though knees in same patient were also attacked but had recovered. Note swelling of affected joint and inflammatory blush.

[To face page 248.

VAN SOMMER

ACUTE ARTHRITIS FOLLOWING EPIPHYSITIS OF THE LOWER END OF FEMUR.

There is much disorganization of the knee-joint.

(Museum, Queen's University of Belfast.)

[To face page 249.

disorganized, and deformity becomes apparent. Meantime constitutional exhaustion is severe from sepsis, pain, and want of sleep.

The **Prognosis** is bad. Death may take place from pyæmia, or later from amyloid disease ; while if recovery takes place, the joint is very rarely movable, being usually fixed, and, if not properly attended to, often in a bad position.

Treatment.—In the early stages, or when the disease is mild or the diagnosis doubtful, the joint should be placed at rest, and Bier's congestive treatment adopted. This may prevent suppuration and cure the condition. If there be reason to suppose that suppuration is taking place, the joint should be immobilized by splints in the position of greatest functional use, and, if there are starting pains, extension by weight and pulley adopted. The joint should be opened and drained at the earliest opportunity, and in cases where simple drainage is not sufficient the joint should be irrigated with a sterile solution or peroxide of hydrogen. Bier's method may be used with advantage after operation.

Excision of the joint may be required as an after-treatment to correct deformity. Amputation is called for if toxæmia threaten life.

Other forms of acute arthritis are met with during the course of various diseases :

In **typhoid fever** joint affections may arise owing to infection with the typhoid bacillus or ordinary pyogenic organisms carried through the blood-stream, and may run their course either with suppuration or without it. The condition may be quite painless.

In **scarlet fever** joint troubles may be caused by the entrance of the scarlet fever virus. It was formerly thought to be of rheumatic origin. There is usually a serous synovitis, which comes on early and especially attacks young adult females, chiefly choosing the wrist-joint and the extensor tendons. This condition is not to be confused with post-scarlet fever arthritis, in which several joints are affected.

Pneumococcal infection of joints is due to the pneumococcus of Fraenkel. The condition produced may be synovitis or acute arthritis. The knee is most frequently affected, and several joints may become involved at the same time. As a rule the joints are attacked a few days after the onset of the pneumonic infection of the lungs, but in other cases there is not necessarily any pneumonia, and the condition is part of a general infection by the pneumococcus, and may be accompanied by endocarditis, peritonitis, or meningitis. This form usually occurs in children, and frequently leads to a fatal termination.

The **Diagnosis** is made clear if some of the fluid be aspirated from the joint and submitted to bacteriological examination.

The local **Treatment** is similar to that for pyogenic infections of different origin. Vaccines are sometimes found useful.

Joint lesions may also develop in the course of **measles, diphtheria, smallpox, dysentery,** or **influenza,** but are not common.

In **acute rheumatism,** as already pointed out, multiple joint infection occurs, but it is usually a synovitis, though sometimes arthritis develops. **Rheumatic arthriti** differs from ordinary acute arthritis in the immediate cause of the affection and in the fact that there is no suppuration, though the process is very acute and the entire join destroyed. It is a rare disease, and does not call as a rule for operative interference. If all other remedies fail, it may be necessary to open and wash out the joint. For further details, see Surgical Complications of Infective Fevers (Chapter XXIX.).

GONORRHŒAL JOINT AFFECTIONS.

These most frequently develop at the period that the urethritis reaches the posterior urethra, but may occur at any time during the course of the disease, and have been met with after all appearance of the affection has ceased. It is questionable whether some of the obscure joint affections occurring in those who have suffered from gonorrhœa at some anterior date may not be due to this source. The organism having lain dormant, and from some cause being stirred to action, chooses a joint for the scene of its activity, just as it may be the cause of a fresh attack of gonorrhœa after having been dormant in the recesses of the urethra for a long period. There is no connection between the severity of a gonorrhœal attack and the occurrence of joint infection. When complicating gonorrhœal ophthalmia, joint affections are usually met with in very young children, and occur as a rule later. The organism is carried by the blood-stream, and deposited in the synovial membrane. In order of frequency, the knee, elbow, ankle, wrist, and fingers, are attacked.

Signs and Symptoms.—The most common form is a chronic synovitis of the knee, in which the joint is filled with a serous or sero-fibrinous exudation. The capsule is not thickened, nor are there any marked local or constitutional symptoms, and movement of the joint is only restricted owing to the amount of fluid present in it.

Treatment.—Rest, under which the exudation subsides, though it may return. Bier's hyperæmic method is of use in many cases, and vaccines injected into the joint give good results. Recovery is usually complete.

SYPHILITIC AFFECTIONS OF JOINTS.

This condition is occasionally caused by injury to a joint in a syphilitic subject, but is generally independent of it.

Pathologically it closely resembles osteo-arthritis, but there is no lipping of the margins of the joints, nor do the eroded areas correspond with the position of intra-articular pressure. The pain is also less severe, and there is no crepitus.

An initial synovitis may occur closely resembling the tuberculous variety, but more rapid in its onset.

Joints are not usually affected by syphilis ; three forms may, however, be met with :

1. **Chronic Synovitis.** — This occurs in the late secondary period. It usually affects the knee-joints, which become distended, but are usually painless. The condition is generally symmetrical.

2. **Gumma.**—Producing chronic arthritis. The gumma may be extra-articular, giving rise to swelling outside the joint, which later on softens and bursts on the surface or intra-articularly. In this variety the synovial membrane is affected by a gummatous condition, which may be local or diffuse. It produces a condition which simulates tuberculous disease, but differs from it in that there is little or no pain, and little destruction of the ligaments and cartilages.

3. **Osteo-chondro-Arthritis.**—A condition which affects the bone and cartilage of the joint. It occurs in congenital syphilis, or at a late stage of the acquired disease. The cartilages become split up and eroded ; the synovial membrane is thick and pulpy in character ; the ends of the bone are usually affected, and become thickened by the chronic

inflammatory process. The condition resembles osteo-arthritis, but is almost painless, and occurs as a rule in younger patients ; while the cartilages are not worn away in the same manner, and there is no lipping of their edges.

The **Diagnosis** of this condition may be difficult if there are no other signs of syphilis nor history of the disease obtainable. The effects of antisyphilitic treatment is the best method of diagnosis.

Treatment.—The treatment will depend on the stage of the disease at which the joint affections make their appearance. If in the secondary stage, mercury and the iodides are administered ; if in the third stage, the iodides are given alone or in larger proportions. Locally, mercurial ointment may be applied to the joint, and firm pressure kept up. Operative interference is not required unless in cases where bony destruction has occurred and the joints are probably deformed.

TUBERCULOUS DISEASES OF JOINTS.

Tuberculous Arthritis.—Almost without exception there is a history of injury to the affected joint, which the patient regards as being responsible for the whole trouble. The injury is as a rule **slight,** and has taken place **some time before any signs appear.** It is seldom that in such cases a history of hereditary tuberculosis cannot be obtained. Where no such history is learned, it is probable that the individual has been in a very low state of health at the time of the injury, but it is doubtful if a trivial injury will ever prove the exciting cause of tuberculous arthritis unless somewhere there is lurking the special predisposition.

At times very curious causes are assigned by patients for this condition. We were consulted on one occasion by a young man who was suffering from hip-joint disease. He had been resident in Ceylon, and attributed his disease to the frequent use he had made of *antivenom*, and for long denied any injury ; at length, however, he remembered having fallen on his hip upon a concrete floor, but no bad results appearing, he had forgotten all about it. It is quite possible that in his case the frequent use of antivenom was a contributing cause of the disease by lowering the patient's vitality.

It is interesting to note that the injury received is usually slight, such as jars, twists, or a fall on the foot, a severe one being less often followed by tuberculosis, since the local activity caused by inflammation disposes of the organisms, should they arrive on the scene.

The *Bacillus tuberculosis* destroys a joint as surely as the *Streptococcus articulorum*, though the pathological changes vary somewhat, being more gradual and having the special characteristics of tuberculous disease elsewhere.

Pathology.—The disease begins in the **synovial membrane** in adults or in the **ends of the bones** in children. Cartilage and ligaments are affected later as a secondary result of the disease.

When beginning in the **synovial m mbrane** it becomes thickened and pulpy, and is dotted over with tubercles. If treatment be carried out early, the process may be arrested before it goes further; if not, caseation takes place, and the joint or the surrounding structures become affected. Suppuration ensues in some cases, and a chronic tuberculous abscess is formed, the degenerated synovial membrane forming a fibrous layer, which is lined with tuberculous granulation tissue. If

repair takes place, the tuberculous foci become surrounded by fibrous tissue, and the granulating surfaces become adherent to one another and form fibrous adhesions.

When the disease extends, the ligaments become soft and disappear, allowing **pathological dislocation** to take place. Those ligaments most closely in relation to the synovial membrane suffer most and earliest.

Secondary to disease beginning in the synovial membrane, the cartilages become eroded from the edges toward the centre, and are eventually replaced by a layer of granulations.

When the disease begins in the **bone ends**, it may start in one of three situations—(*a*) below the articular cartilage, (*b*) next to the growing cartilage either in the epiphysis or in the (*c*) diaphysis. The latter is met with especially in the neck of the femur. The cancellous bone is invaded, and tuberculous caries set up; necrotic patches may be seen in the midst of the caries; caseation and suppuration may follow, and the process may spread under or through the articular cartilage to invade the joint, or break through the epiphyseal cartilage to involve the shaft of the bone. The cartilages are involved earliest when the disease begins in bone under the articular cartilage; the tuberculous granulations then fungate through or detach portions of the cartilage, which act as loose bodies in the joint. The surrounding tissues may become affected early by the disease eating its way through the bone direct, or later when the joint is disorganized.

The periosteum is occasionally affected, and forms new bone, which projects as sharp spicules round the part primarily affected by the disease.

Signs and Symptoms.—One of the earliest symptoms of tuberculous mischief in a joint is slight pain, and this is associated with some impairment of movement. The joint is held in a semiflexed position, and a swelling, more apparent than real, is seen to be present. The joint appears smooth, white, and round; there is local heat, and fluctuation may be detected. There is wasting of the surrounding muscles, which gives a false appearance of considerable swelling of the joint. Pain and swelling increase in a periodic fashion, and the joint after each attack is found more crippled. Abscess formation occurs and further infects the area. Meantime constitutional symptoms increase; there is great suffering from hectic fever, loss of rest by reason of starting pains, and amyloid degeneration may supervene, and death close the scene.

The joint is first distended by fluid and the swollen synovial membrane. As the ligaments are attacked and destroyed, dislocation may take place. When the cartilages have been destroyed, the bone ends become diseased, if they have not been primarily attacked, and may give rise to foreign bodies in the joint from breaking away of small sequestra; or abscesses are formed, which may burst externally and give rise to tuberculous fistulæ, leading frequently to septic infection.

Prognosis.—Much depends on environment. If great care is lavished on the patient, palliative treatment often results in cure. If such care is not obtainable, early radical treatment gives good results; but very frequently procrastination, when there is strong hereditary taint and bad hygienic surroundings, gives little hope of cure from operative procedure, and too often one joint after another becomes affected, while the disease may develop in the lungs or other organs and tissues.

The joint is more likely to regain its function entirely when the

disease originates in the bone. If starting in the synovial membrane, the case must come under treatment very early indeed for such a result to be obtainable ; otherwise adhesions fix the joint, owing to the membrane, and probably the cartilage, being replaced by granulations, which give rise to fibrous adhesions. If the articular cartilage be entirely destroyed, bony ankylosis will result from the ossification of the opposing layers of granulation tissue which have become united. When dislocation has occurred, operation will usually be necessary to correct the resulting deformity.

Treatment.—The patient should be placed in the best possible hygienic surroundings, and the joint kept at rest for a considerable period. When pain and local tenderness have disappeared, the joint should be kept immobilized. Different methods will have to be employed for different joints. Rest in bed is required for some time in the case of the hip-joint, and is advisable for the knee. Most other joints may be placed at rest when the patient is up by means of splints or plaster of Paris. To prevent any deformity that is liable to occur, treatment should be commenced early ; the joint should be placed in the most useful position, should ankylosis occur, and kept there by splints or weight and pulley in the case of the leg. This method of extension also corrects any slight deformity, and acts as a curative agent by overcoming tonic contraction of the muscles and giving the joint rest.

Additional Treatment in Conjunction with Rest.—To relieve pain, **counter-irritation** by cautery or blisters is sometimes carried out.

Passive **hyperæmia** by Bier's method gives very good results in many cases.

Injections of **iodoform** emulsion in glycerine into the joint with or without previous aspiration is a method which has given satisfactory results when carried out sufficiently early.

Lately aspiration of the joint and injection of iodoform emulsion into the sound tissues outside the affected area has been tried with good results.

Injections of **tuberculin** are valuable in assisting to overcome the disease.

If an abscess forms and there is not evidence of a condition requiring radical treatment, it should be opened under strict aseptic precautions.

Radical Treatment.—This may consist of partial or complete excision, and occasionally of amputation.

Partial excision or **arthrectomy** has fallen somewhat into disrepute, since those cases which it cures can as a rule be treated by non-operative methods, and for others it is not radical enough, and the disease usually returns. It consists in taking away the apparently diseased synovial membrane and ligaments, together with a thin layer of cartilage, and aims at securing a movable joint, which it seldom does. The most suitable class of cases for the operation are young children where the bones are not affected, and for whom non-operative treatment is not feasible.

Complete **excision** is indicated where the disease has gone too far for non-operative treatment, or in cases where it has not been of any avail, as shown by the involvement of the bones and the formation of abscesses. It is also the customary procedure to remedy faulty ankylosis. The operation consists in removal of the synovial membrane, cartilages, and ligaments, and the ends of the bones, and fixing

the joint by means of silver wire. It is contra-indicated when there is visceral involvement or great debility.

Amputation of the limb may be required when the general vitality is very depressed, especially when resulting from septic poisoning and lardaceous disease, and when the ankle-joint is extensively diseased in elderly patients.

Arthritis Deformans.

A generic term comprising rheumatoid or atrophic arthritis, osteo- or hypertrophic arthritis, and spondylitis deformans.

Rheumatoid Arthritis.—A slowly progressive disease, usually polyarticular and symmetrical in distribution. It occurs most commonly in young women, and may follow an acute, subacute, or chronic course.

Etiology.—The true pathogeny is still unknown. There are three theories of causation: (*a*) Infective; (*b*) neural; (*c*) a combine of the two former views, in which it is assumed that the disease is due to the action on the nervous system of toxins elaborated in the alimentary canal.

In regard of (*a*) no specific organism has been constantly found either in the blood or joint fluids; and touching (*b*) there is but little or no anatomical evidence of any changes in the spinal cord or peripheral nerves.

The third view (*c*) that the disease is of the nature of a trophoneurosis of infective or toxic origin seems to be gaining adherents; but opinion is sharply divided as to whether the primary cause in this instance is one of subinfection or of auto-intoxication from the alimentary canal.

Leaving this aside, the results of treatment directed to the correction of oral sepsis and gastro-intestinal derangements strongly indicate that the alimentary canal is the primary source of infection.

Morbid Anatomy.—The primary changes occur in the softer structures, the periarticular and synovial tissues undergoing thickening with villous proliferation. In the terminal stages, however, a process of atrophy involving all the constituent elements of the joint ensues, in which the bony and cartilaginous as well as the softer tissues participate.

As opposed to this in **osteo-arthritis,** the primary changes take place in the bony and cartilaginous structures, which undergo enlargement or hypertrophy with the formation of osteophytic outgrowths. This contrasts sharply with the atrophic process characteristic of rheumatoid arthritis, in which, if new bony formation occur, it takes place secondarily, and is inconsiderable in amount.

Symptoms—*Prodromal Stage.*—These consist of vasomotor, sensory, and motor phenomena. Coldness and blueness of the extremities, alternating with white "dead" fingers, is very common. In others neuralgic pains of gnawing or cramp-like character, with paræsthesiæ, are prominent. On the motor side, muscular spasm and weakness, with exaggeration of the deep and superficial reflexes, are notable features.

Acute Forms.—The onset is more or less sudden. It begins in the small joints, spreading centripetally with a tendency to symmetry. It does not flit from joint to joint, the spindle-joint swellings being persistent, and nearly always leaving some residual thickening. The skin over the affected joints is semi-asphyxial in tint or unnaturally white. Local pain and tenderness is slight or absent. The swelling

PLATE XXXII.

Rheumatoid or Atrophic Arthritis: Primary Stage.

Note spindle or fusiform enlargement of mid-phalangeal joints, wasting of interossei, also bluish or cyanotic tint of skin over affected joints.

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PLATE XXXIII.

RHEUMATOID OR ATROPHIC ARTHRITIS : TERMINAL STAGE.

The primary fusiform enlargement of mid-phalangeal joints has undergone shrinkage. Note atrophy of the skin and glossy surface, almost total disappearance of normal wrinkles over mid-phalangeal joints.

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is due to periarticular thickening more than effusion. The temporo-maxillary and cervical articulations are almost always involved. Wasting of interossei in extensor groups of muscles ensues with increased reflexes, while glandular enlargements are not infrequent. Pigmentation, vasomotor troubles, and local as well as generalized sweating are additional features. Cardiac lesions are very rare. The temperature is raised, but low compared with other arthritic diseases, especially considering the widespread involvement of joints. The slight though continuous pyrexia, the quickened pulse-rate, and the persistent nature of the joint swellings, taken together, are very sugges tive of rheumatoid arthritis.

Subacute and Chronic Forms.—In these types the onset is insidious and gradual, the pyrexia less continuous or wholly absent, and the progressive involvement of the joints more tardily achieved.

In the *terminal* stages of all forms the swollen and spindle-shaped joint undergoes gradual shrinkage, until eventually it dwindles to less than normal size. The muscles, at first the seat of spasm, eventually undergo contracture, with resulting distortion of the limbs.

Of complications in the acute stage, complete or larval Graves's disease is the most serious, while more rarely solid œdema of the legs of myxœdematous character has been observed, and, according to some, with notable frequency, a condition of chronic nephritis.

Diagnosis.—Rheumatoid arthritis has to be distinguished from acute articular rheumatism, acute gonorrhœal arthritis, osteo-arthritis, and gout.

In acute rheumatism the vagrancy of the joint swellings, the affinity for the large rather than the small joints, the frequency of cardiac lesions, and the response to salicylates, are the points to rely on.

The following are suggestive of gonococcal infection: Implication of the sterno-clavicular joint, also of the vertebral articulations, iritis or conjunctivitis, and slight constitutional disturbance.

As regards osteo-arthritis and gout, the general clinical features and the local character of the articular lesions, aided by skiagraphy, should obviate error.

Treatment.—The pathological changes in rheumatoid arthritis being usually deemed to be toxic in origin, a search for foci of infection or toxic absorption is our first duty.

The mouth should be carefully examined, and carious teeth, if present, cleansed and stopped or removed. Unhealthy conditions of the gums should be attended to. Chronic nasal, aural, or genito-urinary disorders should be radically treated.

In acute stages patients should be confined to bed, and the affected joints, by appropriate splinting, preserved from ankylosis in improper positions. The splints should be removed once daily, and the joints passively moved. The patient should be clad in light, warm garments. The diet should be carefully regulated, and easily digested fluid nourishment should be ordered, but as soon as possible it should give place to a mixed diet containing meat infusions, such as well-made Julienne, mutton, veal and chicken broth, and raw-meat juice.

Of drugs in the acute stages, salicylate or hydrochloride of quinine and carbonate of guaiacol are useful for their antiseptic and anti-pyretic qualities ; while for pain aspirin, phenacetin, and under strict supervision morphia, may be occasionally invoked.

In chronic stages, if there are signs of intestinal putrefaction, minute doses of calomel are of use, but for routine purposes arsenic and the

iodide of iron are the most reliable drugs. In all instances, however, free evacuation of the bowels by laxatives or intestinal irrigation is essential.

In cases complicated by vasomotor phenomena the tentative administration of thyroid gland is well spoken of by many. In the dietary of chronic cases animal foods should be liberally provided for.

Where possible, these cases should live in dry, warm climates, an occasional resort be had to some spa such as Bath, where they may obtain the advantages of baths, douches, and massage.

Other modes of treatment of great value are ionization, counter-irritation of the spinal column or joints, and treatment by active or passive hyperæmia.

From the surgical aspect much has been done recently, not only for treatment of the joints, but for removal of the cause. In this connection Arbuthnot Lane's procedures for short-circuiting or excision of the colon to remove the sources of infection or toxic absorption are being increasingly practised.

Of local surgical measures, aspiration of the joints and their excision for the rectification of faulty positions have done much to improve the crippled condition, even when of long standing.

Still's Disease.—A special type of chronic arthritis in children, which begins usually before the period of the second dentition. It is characterized clinically by elastic fusiform enlargement of the joints without bony change, and also by swelling of the glands and spleen. Its onset may be acute, with chills and pyrexia, and anæmia is generally present, but there is no tendency to cardiac involvement.

Its causation appears to be obscure, and opinion is undecided as to whether it is to be regarded as a form of rheumatoid arthritis occurring in children, or as a special type of infective arthritis of undifferentiated nature.

The principles of treatment are precisely similar to those laid down in regard of rheumatoid arthritis.

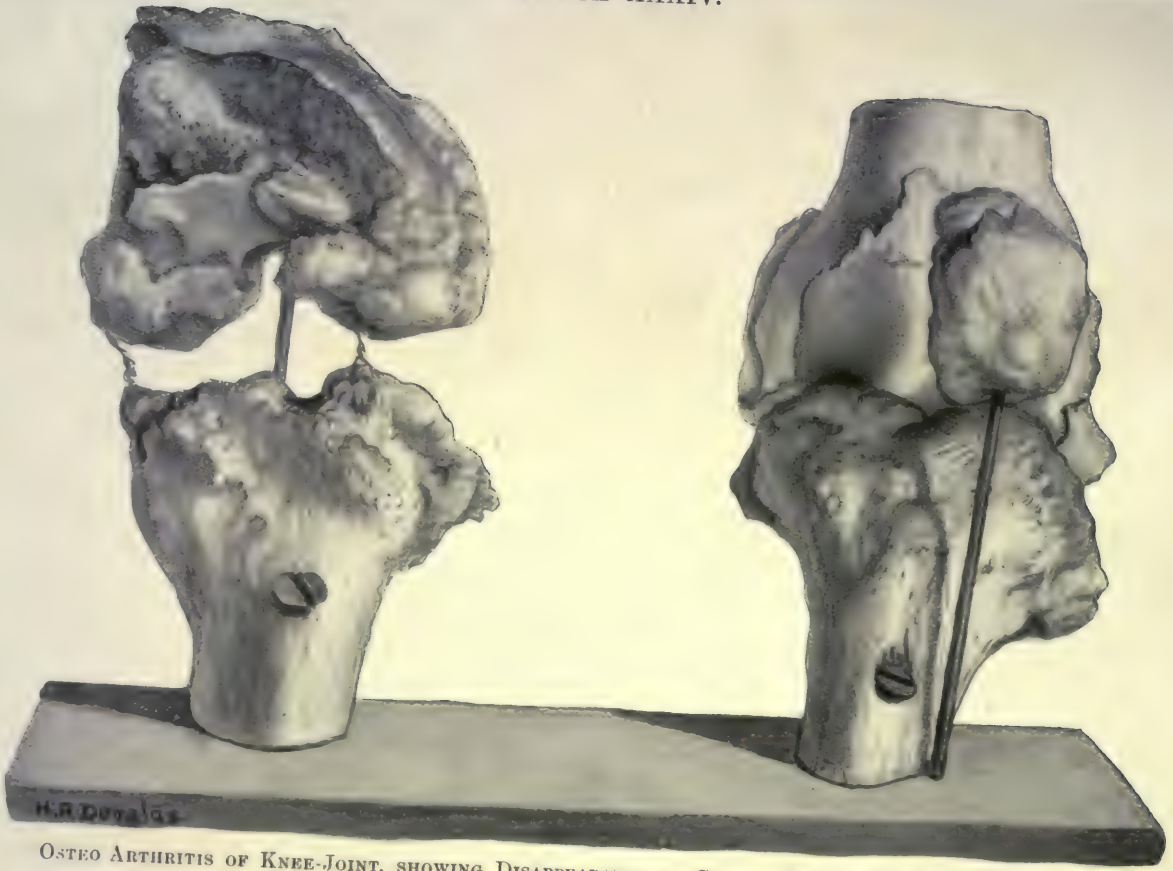
Osteo-Arthritis.—In rare instances this disorder is generalized, but more commonly is of mono- or oligo-articular distribution. It may occur in childhood, but is essentially a disease of middle and later life.

Etiology.—The true pathogeny is still uncertain, but probably the articular changes are capable of production by many different causes acting singly or in combination. Thus it has been variously ascribed to—(*a*) thickening and obliteration of the nutrient arteries of the joint structures; (*b*) infection by sundry organisms, among them Poncet's attenuated type of tubercle; (*c*) an alteration in the secretion of the ductless glands; (*d*) neurotrophic influences.

None of the foregoing theories have been satisfactorily established, and the only definite fact ascertainable in regard of the etiology is the significant frequency with which an element of trauma, either direct or indirect in the shape of strain, can be elicited.

Morbid Anatomy.—Unlike rheumatoid arthritis, the primary changes take place in the cartilage and bone, the synovial tissues being only implicated secondarily, while in character they are active and proliferative instead of being retrograde and passive.

Histologically, the ground substance of the cartilage undergoes segmentation; its cells proliferate and escape into the joint cavity. With the progress of the disease the cartilages, by attrition of their



OSTEO ARTHRITIS OF KNEE-JOINT, SHOWING DISAPPEARANCE OF CARTILAGE AND EBURNATION OF THE BONE.
At the edge of the joint there is a growth of osteophytes.

(Museum, Queen's University of Belfast.)

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PLATE XXXV.

Osteo-Arthritis of the Hand.

Note Heberden's nodosities on terminal phalanges and lateral displacement of these to one or other side. The first metacarpal joint is also the seat of bony enlargement.

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opposing surfaces, become thinned, and the central portion where pressure is greatest being at length worn away, the denuded ends of the bone appear. On the other hand, at their margins the cartilage becomes thickened by irregular crests or nodules, which eventually become ossified.

The osteophytic outgrowths thus developed are the source of the deformity and limitation of mobility in the joint; but though the restriction thus produced may be almost absolute, true bony ankylosis never occurs.

Coincidently the synovial membrane undergoes changes marked by villous overgrowth proliferation of the fixed connective-tissue cells and extensive pigmentary deposit, but in the later stages degenerative changes predominate.

Symptoms.—The mode of onset in cases following severe injury may be abrupt, but commonly it is insidious, years or even decades passing before it arrives at maturity. It attacks both sexes equally, and displays a predilection for the large joints—the hip, knee, and shoulder.

Constitutional symptoms such as emaciation, rapid pulse, pyrexia, pigmentation, and trophic disturbances, are absent, and so contrasts markedly with rheumatoid arthritis.

Of local symptoms, the earliest are slight pain or stiffness in the affected joint, which, more marked in the morning, wears off with exercise. Later on mobility becomes definitely restricted, creaking or grating is heard on movement, and referred pains along the related nerve trunks, such as the sciatic in malum coxæ senilis, are prominent features.

In the knees the disease is often symmetrical, and commonly develops in women about the menopause, and in such cases the earliest symptoms are stiffness, pain, and recurring effusions due to locking of the enlarged villi between the joint surfaces. Later, the outline of the joint, instead of being smooth and rounded, becomes angular, its nodular contour being due to bony outgrowths studding the line of junction of the bones forming the articulation.

In the hands, unlike rheumatoid arthritis, the *terminal* and not the mid-phalangeal joints are the site of election for osteo-arthritic lesions —the so-called "Heberden's nodosities." These enlargements are very common, and the nodes show a marked tendency to progressively involve all the end joints, including those of the thumb. The lateral deflection of the terminal phalanges is due to the thrust of bony outgrowths, these being usually more pronounced on one or other side.

Atrophy of the related muscles may, in the case of the hip or knee, especially the former, be pronounced; but, unlike rheumatoid arthritis, there is little tendency to muscular spasm or contracture. In conclusion, the natural tendency of the disease, if untreated, is to progress, and the older and more inveterate the articular lesion, the more marked the enlargement and deformity produced, but bony ankylosis never occurs.

Prognosis.—This is always somewhat gloomy, owing to the immutable nature of the changes produced, and the older the subject the more sombre the prospect.

Apart from this, all will depend on how far the affected joint can be protected from external and internal traumatism. In the generalized types, of course, the outlook is inevitably dark as regards the joint lesions, but the disease does not as a rule appreciably shorten life.

Diagnosis.—With the *generalized* types of osteo-arthritis the condition most likely to be confused is rheumatoid arthritis, but attention to the following points should distinguish the two affections:

Rheumatoid arthritis occurs in persons under forty years of age, and is much more common in women than in men.

Constitutional symptoms are prominent—pulse quick, temperature often raised, and emaciation common.

In distribution it is polyarticular and symmetrical, with a preference for the small joints. Muscular spasm, wasting, and contractures are prominent features; also vasomotor phenomena and trophic disturbances.

Osteo-arthritis is rare under forty years of age, and affects both sexes equally. Constitutional symptoms are generally absent. In distribution, though it may be polyarticular, it is usually mono- or oligo-articular, with no tendency to symmetry, but displays a marked predilection for the large joints.

Muscular atrophy is slight, hardly ever pronounced; likewise muscular spasm and contracture.

The local character of the articular swelling differs, too, in both affections. In rheumatoid arthritis the skin over the joint is waxy white or semi-asphyxial in tint; the swelling smooth, rounded, and spindle in shape, but with as a rule no bony projection at the line of the articulation.

In osteo-arthritis, swelling, if present, is due to synovial effusion, not to periarticular thickening, hence no spindle-shaped appearance. Joint contour is abrupt and nodular owing to the presence of bony outgrowths.

Lastly, skiagraphy in rheumatoid arthritis shows absorption of the cartilage, with erosion and abnormal translucency of the bones. In osteo-arthritis deposits of new bone at the margins of the cartilages can be detected; also increased density in the shafts.

The localized types of osteo-arthritis—for example, malum coxæ senilis—should be very carefully distinguished from sciatica; also tuberculous and malignant disease of the head or shaft of the femur.

Treatment.—In the generalized types no restriction of diet is called for, and good nourishing food is indicated.

In the localized forms, whether of knee or hip, if obesity be a feature, reduction of body-weight is most essential. To this and the carbohydrate and fatty constituents of the diet should be reduced or even abolished for a time. Bread, sugar, milk, cream, butter, and alcohol should be prohibited. Meat, poultry, fish, game, and all vegetables except the roots and tubers, may be partaken of. Where, as often happens, irregular manifestations of gout are present, the diet must be modified accordingly.

Of drugs in the generalized forms, arsenic, cod-liver oil, and the syrup of the iodide of iron are the most useful.

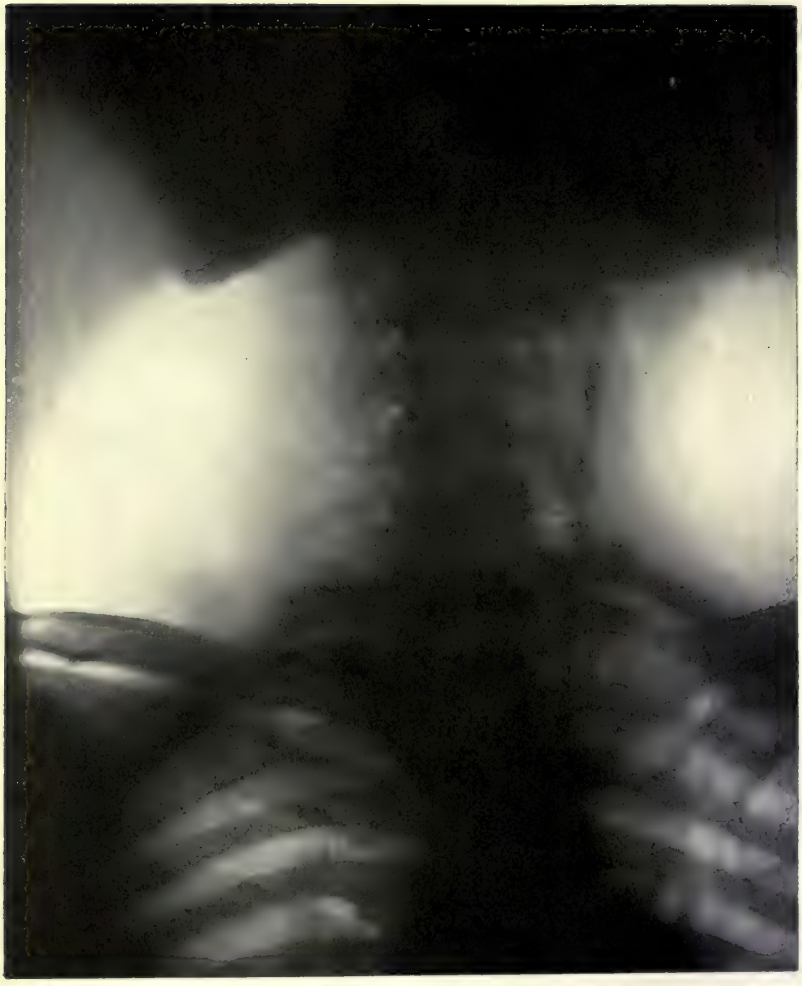
In localized types, guaiacum, sulphur, arsenic, and the iodides, are the most reliable, while for the relief of pain nothing is superior to aspirin.

Of local measures, the primary indication is to remove all sources of strain from the articulation.

In the knees the disease is often symmetrical and associated with bilateral flat-foot, and this static foot error must be carefully corrected.

In malum coxæ, too, such deformities, if present, must be attended

PLATE XXXVI.



Spondylitis Deformans: Antero-Posterior View.

The transverse processes are fixed together by osseous material, and their outlines more or less obliterated in consequence. Ossification of muscle attached to first rib is seen.

(Photo by Dr Bowker.)

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PLATE XXXVII.

SPONDYLITIS DEFORMANS: LATERAL VIEW OF THE SAME CASE.

This shows the osseous outgrowth over the intervertebral discs of two of the cervical vertebræ.

(Photo by Dr. Eowker.)

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to; and if real shortening be present, the sole and heel of the boot must be correspondingly thickened.

If the joints are painful and irritable, relative or absolute fixation is indicated. In the knee this may be attained by firm strapping, bandaging, or well-fitting knee-caps; and in the hip by a spica bandage or some ensheathing apparatus. Such should be discarded at bed-time, and reapplied in the morning after a séance of massage, passive exercises, and exposure to hot air or thermal douches. The massage should be directed chiefly to improving the nutrition and lessening the stiffness of the wasted muscles, and any friction to the actual joint should be very gently applied.

Arthrotomy for the removal of villi is sometimes practised, and osteophytes, where they cause pain by pressure on related nerves, have been successfully removed.

In selected cases excision of the hip-joint has been attended by encouraging results, and the performance of an arthroplasty has also been strikingly successful in some instances.

Spondylitis Deformans.—In this the so-called "central type" of arthritis deformans the intervertebral joints are the seat of predominantly atrophic or hypertrophic changes. The condition may be associated with changes in the peripheral joints of similar nature, or the disease may be restricted to the spine.

The chief symptoms are pain, local and referred, with stiffness of the spinal column, which may be localized to certain regions or may lead to complete spinal immobility.

Nervous symptoms variable in character, intensity, and distribution accompany the malady, such as root pains, atrophy of muscles, with disorders of sensation and motion.

In the atrophic type *la spondylose rhyzomelique* the salient features are its predominance in men and the frequency with which the rigidity and kyphosis of the spinal column is associated with ankylosis of the hip and shoulder joints.

In the hypertrophic or osteo-arthritic type the spine is often fixed in a rigid straight line, with obliteration of the normal curves—the so-called "poker back." Root pains due to pressure by exostoses are common, and in rare instances widespread pressure palsy of the limbs.

In diagnosis care should be taken to exclude tuberculous and malignant disease of the spine, and in doubtful cases the aid of skiagraphy should be enlisted without delay.

Treatment.—All possible sources of local infection or absorption must be treated, and in the acute stages of the malady fixation of the spine is called for. A webbing or canvas belt or corset will suffice in mild cases, and in others a plaster jacket should be fitted. In this way rest is insured, pain is lessened, and deformity arrested or prevented.

The joint should not be kept at rest; on the contrary, the patient should use it to the verge of fatigue. Pain may be relieved by douches consisting of 1 ounce of tincture of iodine to the quart, or by the application of lotion of chloral hydrate, 5 grains to the ounce.

ARTHRITIS URICA (*Syn.:* GOUT).

This is a constitutional disease, the chief sign of which is the liability of certain joints to attacks of inflammation, associated with a deposit of bi-urate of sodium in the articular cartilage, which degenerates, and gouty ulcers are formed, that may extend through the cartilage and attack the bone. There is usually an effusion of synovial fluid into the joint, and an overgrowth of fibrous tissue in the ligaments and periarticular structures, with the formation of adhesions.

The disease usually attacks the metatarso- and metacarpo-phalangeal articulations, and occurs suddenly, often at night. The part is intensely painful, swollen, and red. The more intense symptoms pass off in a few days, leaving the joint tender and swollen.

In osteo-arthritis there is no such sudden onset or intense local suffering, though the damage to the joint is much greater, while special medical treatment is without any effect.

Treatment.—Constitutionally, medical treatment is carried out, and locally some soothing application is employed, and Bier's passive hyperæmia may with advantage be adopted during the acute stage. Later on hot-air baths and massage should be employed. As a rule the joint recovers from the early attacks completely.

CHRONIC RHEUMATISM.

What relation the specific organism of rheumatism has in the causation of this disease is not clear. It may follow acute attacks of true rheumatism, and sometimes exhibits exacerbation with pyrexia, which are amenable to the salicylates ; and there may be a history of rheumatism in the family of the patient, or other signs of it, as chorea, erythema nodosum, etc. The disease may attack the joints or occur as **"chronic fibrous rheumatism"**; frequently one is found with the other.

Pathological Anatomy.—The synovial membrane is at first affected, then the ligaments. The changes consist in cellular infiltration and exudation, which results in the formation of new connective tissue, which enters the joint cavity and causes adhesions between the articular surfaces. The new tissue contracts, and causes stiffness, and later on deformity. The cartilages are subsequently attacked, and may be changed into connective tissue, with resulting fibrous ankylosis and obliteration of the joint cavity. Osseous ankylosis is occasionally met with in the small joints. The ends of the bones may be affected with atrophy from disease, or alteration of form arising from dislocation, but they are not involved in the disease process.

The condition is usually polyarticular, and may be met with at any age.

Symptoms.—Pain may be a prominent symptom, and the patient resists all movements. In other cases movements are easily carried out, but there is considerable creaking. The joint is usually swollen and the muscles wasted, which increases, apparently, the size of the joint. Exacerbations occur. Finally the joint becomes fixed and the patient crippled. Visceral complication may interfere with life.

Diagnosis.—The condition has to be distinguished from rheumatoid arthritis by the disease being confined to the non-bony parts of the

PLATE XXXVIII.

GOUTY ARTHRITIS.

Note large tuberous swellings on knuckle and metaphalangeal joints due to uratic deposits.

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PLATE XXXIX.

Right Hand, The Seat of Chronic Fibrous Rheumatism.

Note excavation of hand and thickening and retraction of palmar aponeurotic structures.

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Vix Sommer.

joints, the association of acute rheumatism which may occur, and also by the exacerbations and the effect of salicylates. In persons with a rheumatic history or tendency, injury appears to be an exciting cause for a manifestation of the disease. It is frequently found that rheumatic pains which had been present previously are more noticed after a more or less trivial accident.

Treatment.—Salicylates during the exacerbations. For the chronic condition treatment at a spa may prove of service to relieve symptoms. Electric and hot-air baths are also useful.

In certain cases arthrectomy is of service, but forcible attempts to remedy stiffness or deformity are to be avoided.

Rheumatic Spondylitis.—This condition usually attacks the cervical region, though any part of the spine may be its seat. It involves either the ligamentous or muscular tissues, while the intervertebral joints are sometimes attacked. Impairment of movement of the head is produced, while the neck may be laterally deflected. Adhesions may form between the bones, and loss of movement be permanent.

The surgeon must distinguish this condition from the result of injury to the spine by accident. The accident may increase the rheumatic condition, or possibly superadd symptoms of its own, which make it difficult to decide which symptoms are due to each. In the majority of cases, however, the presence of the rheumatic symptoms, the absence of any very tender spots, and the improvement under antirheumatic treatment, will serve to clear up the case.

HÆMOPHILIC JOINT.

This is an uncommon condition usually affecting the knee-joint in those who are the subjects of hæmophilia, especially boys. Two varieties are met with—chronic synovitis in the early stages, and osteo-arthritis in the late stages. After some trifling injury, which in the normal subject would produce a sprain, or in some cases without any apparent injury, hæmorrhage takes place into the joint, and acute distension of the synovial membrane occurs, accompanied by heat and pain. The joint cannot be completely extended, the temperature of the body is raised, especially should the hæmarthrosis be accompanied by hæmorrhage elsewhere. The symptoms differ from an ordinary synovitis in being out of all proportion to the injury met with, and the slowness with which the swelling subsides. Chronic and recurrent synovitis usually follows repeated attacks of bleeding into the knee-joint, and later on the signs of chronic osteo-arthritis occur. Well-marked grating may be felt, and the edges of the articular surfaces become lipped.

Pathology.—The blood distending the synovial membrane becomes very slowly absorbed, a deposit of fibrin takes place on the articular surfaces, and by repeated attacks the irritation produces fibrillation, absorption, and thickening of the cartilages. The synovial membrane becomes thickened, and fibrous fringes form, while the ligaments become relaxed. There may be extensive adhesions. The muscles become wasted, and there is considerable stiffness and flexion of the joint, the condition coming to resemble tuberculous synovitis. After a first attack, the blood usually becomes absorbed, and the joint returns to its normal condition. When the attack is repeated, the

pain is less, but the joint does not, as a rule, become again entirely normal.

Treatment.—After a recent hæmorrhage, the joint should be placed in absolute rest, and firm pressure applied. After a few days, massage and passive movements should be adopted to promote absorption of the blood, and to prevent stiffness. All operative interference with the joint should be, of course, avoided. Should such be carried out in error, violent hæmorrhage will result.

NEUROPATHIC ARTHRITIS.

Charcot's Disease.—An arthritis arising usually in locomotor ataxia was first described by Charcot. It usually develops in the ataxic stage, but occasionally may appear as the first symptom of the disease. The joints most usually affected are those of the lower extremities, and the disease is often bilateral. The condition is frequently excited by an injury to the joint.

Symptoms.—Swelling of the joint occurs, and may extend for a considerable extent beyond it. There is, however, no redness or heat, and **no pain on movement,** while the swelling is tense and does not pit on pressure. The joint may continue in this condition for some time, but in many cases destructive changes occur with extraordinary rapidity, the joint becoming enormously distended, and the changes of osteo-arthritis taking place. The joint itself becomes extremely weak, owing to destruction and stretching of the ligaments. Occasionally there is great development of new bone in the capsular ligament, which increases the deformity already present. The most diagnostic points in the condition are the absence of all pain or tenderness, the sudden onset, with swelling and rapid destruction of the joint in the more severe cases.

In **Syringomyelia,** joint affections occur fairly frequently, those of the upper extremity being usually affected. The condition simulates Charcot's disease, but is seldom symmetrical.

Following **division or compression of peripheral nerve trunks,** especially in the hand, the joint may become distended and painful, and occasionally deformity, rarely bony ankylosis, results.

Treatment.—Locally, this consists in supporting and protecting the joints, and when there is much distension aspiration should be carried out. When the joint is one of those of the lower extremities, crutches should be used to enable the patient to get about. The general treatment is that for the nerve lesion causing the arthritis.

HYSTERICAL AFFECTION OF JOINTS.

These conditions are usually met with in neurotic young females who have little else to do but think about imaginary ailments. They are, however, sometimes met with in men. Some slight injury or exposure to cold is usually blamed for the occurrence, and all the symptoms of organic joint disease may be simulated. The symptoms, however, commence suddenly, and without any sufficient cause. The two principally complained of are **neuralgic pain** and **stiffness**; when tenderness is alleged to be present, a slight touch is said to produce more pain than firm pressure. The symptoms come and go without

reason, and when the attention of the patient is taken off the part, the joint may be moved with ease. Enlargement of the joint may be simulated, owing to wasting of the disused muscles.

The condition may be easily mistaken for one of organic trouble, and in doubtful cases a radiograph should be taken, or the joint examined under anæsthesia.

Treatment.—Locally, the general condition of the part should be improved by massage, baths, and the electric current, and in obstinate cases the actual cautery is of great value. The general treatment consists of improving the condition of the nervous system, and the rest cure may be resorted to when the patient does not improve under the ordinary conditions of life.

Neuropathic Hydrops.—This is a condition of a somewhat different sort from hysteria. Here there is actual enlargement, the joint being filled with fluid, and its movements restricted. The swelling lasts for several days, and then subsides, but recurs at regular intervals for a period of several years. The treatment consists in building up the nervous system by means of tonics. After the swelling has subsided, the joint should be massaged. This treatment should be adopted before the regular period of the return of the swelling.

TUMOURS AND CYSTS.

New growths in the synovial membrane are very uncommon. Cartilaginous tumours and sarcoma are met with. Their growth is attended with an exudation into the joint, which in the case of sarcoma is blood-stained.

The cysts found in connection with joints include cystic distension of bursæ, which communicate with the joint; **Baker's cysts,** which consist of hernial protrusions of the synovial membrane; and ganglia, which are formed in relation to the capsular ligament.

In most cases they should be left alone. If giving rise to pain or inconvenience, they may be excised, care being taken to close the communication with the joint.

LOOSE BODIES.

Loose bodies in joints may be of various origin. Thus, they may be fibrinous, and give rise to the characteristic melon-seed bodies. They are formed in cases of **tubercle** and in **chronic synovitis,** and may also be met with in **osteo-arthritis** and **Charcot's disease.** Their presence is usually associated with effusion into the joint, and they result from a coagulation of the fibrin-forming elements in the exudate or from a coagulation process and degeneration of the superficial layer of the synovial membrane.

Symptoms.—The bodies become moulded in various shapes by the movements of the joint, but, owing to their consistence, they do not give rise to the symptoms of a hard body between the articular surfaces. Their presence is usually recognized by the sensation of crepitus given to the hand when the joint is moved.

Treatment.—In addition to the treatment of the joint disease responsible for the formation of the bodies, it may be necessary to free the joint of their presence by operative means.

Foreign bodies may also be composed of **Organized Connective Tissue,** and are usually formed from an overgrowth of the synovial fringes. They may consist of fat (arborescent lipoma), fibrous tissue, or cartilage. These pedunculated growths may remain attached to their stalk, or may separate. Bodies formed in this way are usually met with in joints which are affected with some chronic disease, as osteo-arthritis, tubercular synovitis, etc. Bodies may also be formed by a portion of the lipped articular cartilages in osteo-arthritis becoming broken off, or by portions of bone in relation to the capsular ligament becoming necrosed or broken off, as in Charcot's disease. These will usually grate upon one another.

The **Symptoms** with this type of foreign body are those of the originating disease, and occasionally of impaction of the body between the articular surfaces.

Treatment is that of the disease, and the removal of the foreign body when necessary.

Loose bodies also occur in joints which are **otherwise healthy.** Their origin is not very clear. Many believe that they are pieces of bone or cartilage from the articular surfaces detached by injury or by a pathological process—the " osteochondritis dessicans " of König. The foreign bodies are occasionally due to **Multiple Chondroma of the Synovial Membrane,** in which the surface is covered with small hyaline cartilage particles which become detached.

The **Symptoms** of a foreign body in a healthy joint are sudden onset of acute pain, with a momentary locking. Synovitis may supervene. The foreign body may often be detected, when in the knee, on the inner side of the patella. If not removed, the joint may become discrganized.

These classical symptoms are not always observed. Thus, the patient may complain only of " rheumatic " pains, some cracking of the joint, and a slight impairment of function.

The knee and elbow are the most frequent sites of these foreign bodies.

The **Treatment** is to remove the body by an open incision. Previous transfixion of the loose body will render the operation easier and more certain.

ANKYLOSIS OF JOINTS.

Ankylosis may be—**False,** when it is due to extra-articular causes, as the contraction of skin, muscles, and tendons ; the matting together of the tissues subsequent to injury or disease of the part ; and new growths of muscle or bone. In this form there are often signs of extra-articular injury or disease, and the movements of the joint, though restricted, are yet fairly free and practically painless.

True or **Intra-Articular Ankylosis.**—This may be **fibrous** or **bony.** In the **fibrous** form the fixation is not complete, but movement causes pain. It results from certain forms of synovitis and arthritis, and injuries near to or involving the joint, as a fracture of the elbow, where fixation of the part has to be maintained for some time.

In this class of injury there is also some extra-articular ankylosis. It also follows certain nerve lesions, as syringomyelia and disease of, or injury to, a peripheral nerve.

In **bony ankylosis** there is complete fixation, brought about by destruction of the articular surfaces and the union of the bony surfaces.

Attempted movement causes no pain. The condition usually results from an acute arthritis or from chronic tuberculous arthritis.

Treatment of Ankylosis.—After active disease has disappeared massage and active and passive movements should be carried out. Hot-air baths are a useful adjunct. In fibrous ankylosis forcible movements under an anæsthetic are often required to break them down. This is followed by massage and passive and active movements. In tuberculous cases all violent movements should be avoided, and for the correction of deformity gradual correction, as by weight extension, should be employed.

Excision of the joint with subsequent passive movements may be carried out for bony ankylosis, as in the elbow and shoulder.

Excision with subsequent fixation may be carried out for bony ankylosis in a faulty position, and for weak painful fibrous ankylosis. This is chiefly done in the hip and knee-joints.

Coxa Vara.—See Deformities, Chapter XIV.

The "bone-setter" reaps a rich harvest from the treatment of ankylosis, which often results in disaster to the patient, since the former frequently seeks to render joints freely movable which are still the seat of active disease. It is well for the student to remember, however, that much may be done to restore function to the joint. There is no mystery in the movements of joints. They are for the most part simple and straightforward, and if their anatomy and radius be remembered, the joints may be moved in the normal directions with a little manual dexterity, so long as the operator is assured that there is no active diseased condition present. The student should acquire this dexterity in dealing with bones and joints, and be able to recognize what conditions are extra- and what intra-articular, so that in later life he may be able to employ such means in dealing with suitable cases.

AFFECTIONS OF SPECIAL JOINTS

THE SHOULDER.

This joint is seldom the seat of acute inflammatory disease or of tuberculosis.

It is infrequently affected in children unless by extension from the upper epiphysis of the humerus, which is partially included in the synovial membrane. This, it should be remembered, is prolonged down the bicipital groove, so that pus, etc., may extend down the arm from the joint by this route. A communication also often exists between the joint and the subdeltoid bursa.

Osteo-Arthritis.—This is comparatively common in the shoulder-joint, and is frequently followed by ankylosis of the extra-articular type, which is also met with after traumatism and brachial neuritis. The frequency of ankylosis is probably accounted for by the fact that when the shoulder is fixed its movements are to a great extent compensated by those of the scapula on the back of the thorax, so that the patient is encouraged to hold the painful joint in prolonged rest.

Tuberculosis.—This is usually met with in the right shoulder of young adults. The disease, as a rule, begins in the head of the humerus,

and at times does not involve the joint, or it takes the form of *caries sicca*. A large part of the head may disappear, and occasionally part of the bone or of the glenoid cavity may form sequestra. Tuberculous hydrops is rare.

If an abscess form, it points along the bicipital groove or under the posterior border of the deltoid muscle.

The symptoms are pain, with rigidity and wasting of the deltoid and scapular muscles. There is often tenderness over the upper end of the humerus. When the articular surfaces are extensively involved, there are starting pains, and the arm is usually shortened. The axillary glands may be enlarged.

Diagnosis.—The disease has to be distinguished from **osteo-arthritis,** in which the movements are accompanied by creaking or grating; from **disease** of the **subdeltoid bursa,** in which there is no rigidity or signs of movement of the articular surface; from **paralysis** of the **deltoid and scapular muscles,** in which there is, as a rule, no pain and greater freedom of the joint; from **sarcoma,** in which there is a more rapid history. A radiograph will generally clear up any doubt.

Treatment.—The joint should be immobilized in slight abduction by means of a plaster of Paris spica bandage carried round the thorax and arm. Excision of the joint is carried out when other measures fail to give good results.

Pyogenic Disease.—Secondary to periostitis and osteomyelitis of the humerus or suppuration in the axilla, this condition is sometimes met with.

Neuropathic Arthritis.—In the shoulder this usually occurs in cases of syringomyelitis, and produces a large painless swelling, wasting of the deltoid and scapular muscles, and disappearance of the upper end of the humerus.

ELBOW-JOINT.

Osteo-Arthritis, Neuropathic Joint (in syringomyelia), **Pyogenic Diseases, Bleeder's Joint, Syphilitic Disease** (in young children), and **Loose Bodies,** are all met with in the elbow-joint, but are rare, except the last, occurring in a healthy joint, and call for no special mention.

Tuberculous Disease.—This is common in the elbow-joint, and may be met with at any age, though usually affecting those under twenty. If the disease is confined to the synovial membrane, it is very insidious, and gives few signs. Pain is usually absent, though it was a marked symptom in an early case recently seen by the author, and the only movement interfered with is complete extension. The disease is evidenced by a white swelling on both sides of the olecranon, and extending above it Later on there is wasting of the triceps muscle, involvement of the articular surfaces, and perhaps the formation of an abscess. If the articular surfaces are affected with caries, without swelling of the synovial membrane, which is rare, pain is marked, and there is much restriction of movement. Foci of disease may be found in the upper end of the ulna and lower end of the humerus. The joint is usually involved, on account of the smallness of the epiphysis, and disease in one bone end usually involves the other. If an abscess forms, it usually does so beneath the triceps, and points at either edge of the muscle.

Treatment.—This should be conservative as long as possible, especially in the case of children. The limb is immobilized by means of a wooden or poroplastic splint, flexed to rather less than a right angle, with the hand semi-pronated.

When the articular surfaces are involved, the joint is opened and scraped to remove caseous foci. If the disease has so progressed that ankylosis is likely to occur, arthrectomy or excision is performed to cure the condition and give a useful joint. If a strong joint with bony ankylosis is required, the joint is fixed at a little less than a right angle.

WRIST-JOINT.

The arrangement of the flexor sheaths in relation to the carpal joints favours the spread of infective processes of one to the other, and also the arrangement of the synovial membrane enables the disease to spread through the various articulations in the region of the wrist.

Tuberculous Disease.—This may occur at any age, but usually affects young adults. It is often of a chronic type, and difficult to deal with on account of the number of joints involved. A puffy white swelling occurs on the dorsum and obscures the bony landmarks. It extends to the side of the joint, and down towards the metacarpal bones. There is wasting of the thenar and hypothenar eminences, while in front of the wrist the hollows above and below the anterior annular ligament are filled up. Pain is constant and severe when the articular surfaces become involved. The wrist is held slightly flexed, and the fingers stiff owing to adhesions in the tendon sheaths ; an abscess may form and be followed by sinuses.

Treatment.—This should be conservative for as long as possible. The forearm, wrist, and metacarpus should be immobilized with the hand in dorsiflexion. If iodoform is to be injected, the needle should be inserted below one of the styloid processes. When the disease has proceeded further, and the tissues break down, the bones and synovial membrane involved should be removed, and all affected tissues scraped away. These partial operations should be repeated, and only in extreme cases should complete excision be done. Occasionally amputation is required.

Osteo-Arthritis and **gonorrhœal disease** are fairly frequently met with in the wrist, while pyogenic affections and various forms of rheumatism are comparatively rare.

SACRO-ILIAC JOINT.

Tuberculous Disease.—This usually affects young adults. It causes a puffy swelling over the joint, and gives rise to an apparent lengthening of the leg, due to tilting of the pelvis. Movements of the hip-joint are not interfered with, however. When an abscess forms, it points either posteriorly in the gluteal region, through the sacro-iliac foramen, or may burst into the rectum or the vagina. Lateral pressure over the two ilia produces severe pain. There is a sense of weakness when the patient stands or walks, and the pain is often referred down the back of the thigh. If only the peripheral parts of the joints are affected, there may be no symptoms.

Treatment.—The joints should be immobilized so long as the disease is active. If an abscess forms, it should be opened posteriorly and all diseased bone removed. Subsequent to the operation, an immobilizing jacket should be worn for a long period ; see also Diseases of Spine (Chapter XX.).

THE HIP-JOINT.

Owing to the deep situation of this joint, it is not possible to detect early the onset of disease, which is usually first indicated by a limp, or some restriction in the movements of the joint. When examining a suspected case, the length of the two legs should be compared, and the relation of the great trochanter to Nélaton's line ascertained. Next the position of the limbs with regard to the pelvis should be noted, and also whether the latter is tilted.

Tuberculous Disease (Morbus Coxæ).—This is usually met with between the ages of five and fifteen.

Pathological Anatomy.—The disease may begin in the bone or in the synovial membrane. The former is the more common, and occurs either under the head of the bone near the epiphyseal cartilage, or in the acetabulum. It may spread through the acetabulum into the pelvis, from the neck and the shaft to the great trochanter ; or starting in the synovial membrane, it may spread to the psoas bursa and into the pelvis. The ligaments are invaded, and the ligamentum teres in many cases disappears early. The posterior part of the capsule may be perforated ; the anterior part is usually the last ligament to give way. The head of the bone is stripped of cartilage and becomes carious ; necrosis takes place, and a sequestrum forms owing to interference with the blood-supply by destruction of the vessels in the ligamentum teres, or their occlusion by disease of the synovial membrane. The acetabulum becomes carious and may be perforated and worn away by pressure ; new bone is formed above and behind the diseased acetabulum, to which progressive enlargement of the socket the name of " wandering " or **" travelling acetabulum "** was given by Volkmann. Carious foci may occur in the neck of the femur, and spread either down the shaft involving the trochanter and forming a chronic tuberculous abscess, or enter the joint. The joint becomes ankylosed by fibrous bands, or true bony ankylosis may take place, owing to union of caseous bone surfaces, with subsequent ossification. The joint may become dislocated owing to destruction of the acetabulum, or the head or neck of the femur, or owing to destruction of the ligaments and contraction of the muscles.

Signs and Symptoms.—Three stages of the disease are usually described, but there is no hard-and-fixed line of demarcation between them.

First Stage.—In this either the synovial membrane is alone affected, or there is a focus in the neck of the bone, which does not communicate with the joint. Pain is complained of in the hip or referred to the knee, owing to the common nerve-supply. Wasting of the muscles of the thigh occurs, there is some fulness of the inguinal region, and the gluteal fold is obliterated and the nates flattened. The patient is frequently brought for advice on account of his health, or because he has some pain and a limp when he walks. An injury may be told of, or the history of such an occurrence elicited, some weeks

TUBERCULOUS DISEASE OF HIP-JOINT.

The disease has eaten through the acetabulum.

(Museum, Queen's University of Belfast.)

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having usually elapsed before the onset of any symptoms. The limb, on examination, is found to be flexed in order to relax the vertical limb of the Y-shaped ligament, and abducted to relax its oblique one; it is everted by the weight of the limb. There is **apparent lengthening,** owing to tilting forwards of the pelvis on the diseased side to counteract the abduction of the thigh. Lordosis of the spine is present to compensate the flexion of the thigh. Pain is elicited by upward pressure on the heel or knee or on the great trochanter, and by movements of the joint, which are limited, especially those of extension, adduction, and inversion. When the limbs are quickly separated, the affected one moves with the pelvis as a whole.

The *Second Stage*, in which there is destruction of the cartilage and the ligaments of the joint, is marked by an increase of pain and by "starting pains" at night, which are caused by the relaxing of the muscles as the patient falls asleep, allowing the diseased head of the bone to come into contact with the acetabulum. Rigidity now becomes very marked, and the leg is held in flexion and adduction, owing to the failure of voluntary muscular movement and the muscular power of the adductors being greater than that of the abductors. The leg is also inverted owing to the giving way of the posterior part of the capsule, and perhaps to the involvement of the short external rotators, in the disease. There is now **apparent shortening** of the limb, owing to the tilting up of the pelvis on the diseased side, in order to overcome adduction. Lordosis and scoliosis are also present.

The Third Stage.—This is marked by the destruction of bone. Similar pains to those above mentioned are still present, and there is also hectic fever. The position of the leg is similar to that of the second stage, but of a more exaggerated degree, and there is **actual shortening,** which is due to the destruction of the head of the bone and the acetabulum, or occasionally to dislocation or fracture of the neck of the bone.

Abscess formation is common, and it may point to the inner side of the great trochanter in the gluteal region or in Scarpa's triangle, and occasionally it points, or bursts, inside the pelvis into the rectum, bladder, or vagina. There are many other situations in which a sinus may open on the surface from disease of the hip-joint. When the abscess bursts, septic poisoning very often takes place, giving rise to hectic fever and amyloid disease. If these sinuses are scraped and packed with iodoform gauze, they heal fairly soundly, and the patient may be immune for a considerable period.

Diagnosis.—Tuberculous hip-joint disease is to be distinguished from other diseases affecting the joint, and also from those which occur in its vicinity. It is always well that the patient should be made to strip and his gait on walking noted. Having done this, he should be examined while lying on his back, and the length of the two limbs measured. The position assumed by the leg and by the pelvis is then to be noted, and the effect of movements at the hip-joint. It is often not possible to decide at once what is the condition present, and the patient should then be examined again, and if there is any doubt, an X-ray photograph taken. In very young patients **congenital dislocation, coxa vara,** and **infantile paralysis** have to be excluded. In these the history is not of the same kind as in tuberculous disease, and the movements are more free. It is well to be very careful in observing whether the movements are restricted at the

hip-joint or not, and especially whether rotation is present; thus in **sacro-iliac disease** the pelvis may become tilted and the limb lengthened, but the movements of the hip-joint are normal; while in **disease of the great trochanter** the movements at the joint are less restricted, but the condition closely simulates hip-joint disease. In the case of a **psoas abscess,** the result of spinal disease, and in diseases of the psoas bursae, the movements at the head are only restricted in extension and inversion. Frequently, too, there is rigidity of the spine and some deformity. In **New Growths** near the hip there is little or no rigidity at the joint, but the diagnosis is often difficult. Occasionally, especially in children, such conditions as **appendicitis** and **inflammatory trouble** in the groin or the upper end of the femur, may simulate tuberculous disease, but true movements of the joint are not interfered with. Occasionally **sciatica** simulates hip-joint disease, but careful examination cannot fail to indicate the true condition.

When the synovial membrane is affected, passive movements give almost as much pain as active ones, while, when the disease affects the bones chiefly, passive movements are not at all so painful as active ones.

Prognosis.—This is always rather serious in the case of tuberculous disease of the hip-joint, and its degree depends upon the lesions of the bones and the infection of sinuses; at the same time recovery is frequent, especially when the hygienic surroundings can be maintained at a favourable level. Recovery is slow, and even in quite early cases, when there is not much involvement of tissue, it need not be expected in a shorter period than two years, while complications and relapses are common, and cause tedious delay. As a rule, recovery is attended with some impairment of the function of the joint, and in cases where destruction of the articular surfaces has occurred, the limb is liable to be shortened and a stiff joint to result. When the case terminates fatally, it is usually owing to extension of the disease to other tissues of the body, especially the meninges and the lungs, or owing to septic posioning.

Treatment.—A very large number of the cases may be treated on the conservative plan, as it frequently gives good results, and anything in the nature of operative treatment is almost constantly followed by more or less loss of function.

The patient should be put to bed, with a weight and pulley extension, until the flexion and some degree of the other malpositions, abduction or adduction, have been remedied. The weight used will vary in the case of children between 1 and 4 pounds, and in the case of adults from 10 to 15 pounds. Each case must be judged on its own merits in regard to the weight required. Sometimes the pain comes back after having been relieved; it is then due to a stretching of the ligaments, and indicates that the weight should be removed temporarily, or at least diminished. The pain and tenderness usually disappear under extension treatment, which is kept up for about one month. In certain cases the deformity is not remedied by extension; the advisability of administrating an anæsthetic and correcting it may then be considered.

When the limb has been got into good position, a Thomas's hip-splint, or, in the case of young children, a double Thomas's hip-splint is applied, a patten is worn on the sound leg, and the patient is encouraged to walk about on crutches, which may require a little training. When a patient cannot be kept under close observation,

plaster of Paris may be applied in lieu of the splint. The bandage should immobilize the pelvis, thigh, and leg. This treatment should be continued for about a year, and the time to take off the apparatus will be indicated by the absence of pain and tenderness, and the demonstration by the X rays that active disease has ceased. If, in the course of this treatment, an abscess should form, it is to be treated on general principles for tuberculous abscess. Injection of **tuberculin** vaccine is of great benefit to promote healing of sinuses, and to arrest the progress of the disease.

Operative Treatment.—There are many views as to whether this should be resorted to or not. Those who are opposed to it say that the disease, in whatever stage, will always yield to conservative methods, and those who advocate it say that whenever a joint does not speedily recover by conservative methods, it should be operated upon. Probably the *via media* is the proper course to adopt, since experience would seem to teach us that, owing probably to personal idiosyncrasy, some cases, even bad ones, can be cured by conservative methods ; while others, even mild ones, cannot be cured, a great deal depending upon the reparative power held by the tissues of the individual. A useful indication as to the necessity for operation is obtained by examining with the X rays from time to time.

Arthrectomy.—It is held by some that this operation, without excision, is of little use, since in the cases that might benefit, non-operative methods are likely to be successful. This view is, however, not to be strictly adhered to, as there are cases which do not seem to yield to conservative methods, and yet, when diseased tissues have been removed without doing much damage to the normal structures, good results follow.

The joint is opened either from behind or in front, the head of the femur is dislocated, and all the affected synovial membrane is scraped or dissected away, together with all foci of the disease existing in the neck of the bone or the acetabulum. The surfaces having thus been rendered healthy, the wound is closed, and some degree of function may be retained by the joint.

Excision.—Where it is found that the disease has infected the head and the neck of the bone to a considerable extent, the neck should be divided and the diseased part taken away. The remaining part of the neck is then placed firmly in the socket, and the limb put up in abduction in order that close union may take place between the neck and the acetabulum, and also to compensate for the shortening of the limb by tilting the pelvis downwards on the diseased side. It should be kept in this position for about six weeks, at first by splint, and later by plaster of Paris.

Amputation is now rarely called for, but it may be indicated where the disease has attacked other joints of the limb, or where it progresses after operation, and septic sinuses persist.

Operations for Ankylosis.—It sometimes happens that the surgeon has to treat a case in which deformity results from neglect or bad treatment; but the active disease has ceased, and the faulty ankylosis may be combined with contraction of the soft parts. It is well not to be too hasty in trying to reduce these deformities, unless they seriously inconvenience the patient. When it is decided to operate, the deformity may be remedied by osteotomy through the neck of the femur, or the trochanter. The former is called " Adam's operation." These operations remedy deformity with flexion. If the flexion is

caused merely by the contraction of the soft parts, this may be remedied by extension or by division of the contracted parts, after which the limb is put up in marked abduction.

When the deformity is adduction and inversion, Gant's operation may be performed. This consists of a transverse osteotomy carried out below the trochanters. Sometimes an oblique osteotomy corrects the deformity better. Where the soft parts are the principal or auxiliary factors in the deformity, they should be divided and the limb put up in abduction.

Rarely both hip-joints may be affected. Here conservative methods are called for. The patient, as a rule, has to be confined to bed for a long time. Walking, subsequently, in at all bad cases, will be very difficult, especially when the joint has become fixed in a faulty position, and operation will aim at securing a movable joint on one side. Of course, in these cases, as in those where one joint is affected, conservative methods may be crowned with success, and the patient able to walk with comparatively little loss of power.

Other Affections of the Hip-Joint—Osteo-Arthritis.—This is a fairly common condition of the hip-joint, and is often predisposed to by injury, such as an intracapsular fracture of the femur. The disease most usually attacks the old, and produces a shortening of the leg with raising of the great trochanter. There is flexion and abduction, and, in the late period of the disease, locking may occur, owing to the presence of osteophytes. Usually creaking and grating of the articular surfaces can be elicited, and the patient complains of an increase of pain in the morning or after having rested the leg. Treatment is as a rule of little avail, but is best directed to an attempt to maintain the natural movements of the joint, and to relieve pressure on the articular surfaces by the use of artificial aids, such as crutches and sticks. When occurring in young people otherwise healthy, excision of the joint may give good results.

Charcot's Disease may be met with in the hip-joint usually in middle-aged men suffering from tabes. The condition is sometimes bilateral. When unilateral, a Thomas's splint may be worn, and the affected joint, or joints, protected and supported, as far as possible, while treatment of the disease causing the condition is carried out.

Septic Conditions of the hip-joint are not common in adults, but may be met with in children and young people. The organisms responsible may be ordinary pyogenic ones, gonococci, pneumococci, or the organism of typhoid fever. Entrance to the joint is usually obtained through the blood-stream, but occasionally direct infection occurs following suppuration in the neighbourhood of the joint. The condition may not be observed until late, and fixation or dislocation of the joint being perhaps the first symptom. The position of the limb is usually that of flexion and adduction. In children, if dislocation occurs, it may be mistaken for congenital dislocation. When the condition is recognized early, the limb should be extended by weight and pulley. If suppuration has occurred, the joint should be opened and drained. A cure, especially in children, may be brought about by these means.

THE KNEE-JOINT.

This joint is very commonly affected by injury and disease. The arrangement of the synovial membrane should be borne in mind. It extends underneath the quadriceps extensor in a cul-de-sac, which may communicate with the subcrural bursa; when it becomes distended with fluid, as in synovitis, the pouch bulges out, and the patella floats, or rides, above the condyles of the femur, against which it may be tapped. This distinguishes the condition from bursitis, in which case the fluid is above the patella, and the bone cannot be felt distinctly. It should be remembered that the semi-membranous bursa frequently communicates with the synovial membranes of the knee, and may become enlarged in disease of the joint.

Tuberculous Disease.—This is very common in early life, but may occur later. In children the condition begins in the bones, and in adults in the synovial membrane. It may be divided into three stages. In the **first** there are signs of synovial distension, the membrane bulging above and on each side of the patella, and eventually coming to surround it, something like a horseshoe. This distension may be due to fluid or a doughy kind of substance. Later on a spindle-shaped swelling is formed, especially noticed in children, and the size of the swelling is apparently much larger than it really is, owing to the wasting of the muscles. In the **second** stage some displacement occurs, and the tibia may be pushed backwards and outwards, while the joint is held in flexion; and there is external rotation. This is largely owing to the action of the hamstring muscles. In the **third** stage there is shortening of the femur or tibia, or of both, when both are affected, owing to destruction and absorption of bone.

Types.—The disease may be observed as a **hydrops,** which is marked by fluid in the joint, and is usually of purely synovial origin. The condition is met with in young adults. As a rule the disease begins gradually, with little pain or interference with function. This form of synovitis is to be distinguished from the purely traumatic one, in that the condition is **painless,** of **insidious origin,** and the skin is white and cool to the touch; and the history of an injury, if there be one, is of comparatively old standing and of a slight nature, whereas in the case of the traumatic condition, the fluid gathers quickly, the skin is hot, there is considerable pain, and the history is of a recent severe injury.

The disease may occur as **tuberculosis of the synovial membrane of a nodular type,** in which there is growth of the synovial fringes. It is that usually met with in adults; the onset is insidious, the patient usually complains of some stiffness and swelling in the joint, both of which are increased by exertion. Occasionally the joint becomes locked owing to the existence of a loose body, probably a part of the synovial fringe. This is to be differentiated from a loose semilunar cartilage, usually by the history of swelling of the joint.

An **abscess** may form. This is rather rare. The joint becomes filled with pus, the health of the patient is usually of a low type, and in this case the disease may be acute, a good deal of fever being present. When occurring in adults, it is usually chronic. The pus should be withdrawn. The injection of iodoform into the joint often proves beneficial.

There may occur a **general thickening of the synovial membrane.** While the disease is confined to the membrane, it gives rise to an elastic spindle-shaped swelling of the joint. The patient limps, the knee is held semiflexed, and the articular surfaces become involved. Pain is caused by jarring, and the joint is therefore held rigid, and the muscles waste, causing the joint to look larger than it is. Starting pains are noted at night, and disturb the patient's rest. Flexion increases, and outward rotation is noted. This is a condition which is very commonly met with, and to which the term **white swelling** has been applied. The X rays are useful in diagnosis to show the difference between tuberculous destruction of joints and new growths, such as sarcoma (see Chapter IV.).

The bones may be primarily affected, and the disease may be detected by means of the X rays when it has caused distension, but is hard to recognize earlier. When the disease penetrates to the surface of the bone, beyond the synovial membrane, there is great tenderness and pain on walking, and a cold abscess may develop. The question of the early infection of the joint by this form of the disease will depend upon the direction in which it progresses. If it reaches the surface beyond the limits of the lining membrane, the joint will probably not be very greatly affected ; but if it penetrates and perforates the articular cartilage, the joint is infected, either suddenly, in which there is fairly rapid suppuration and destruction of the joint, or gradually, in which case a dry arthritis takes place.

An extra-articular abscess may be formed in tuberculous disease of the knee. It may originate in the synovial membrane, in the surrounding cellular tissue, or in one of the popliteal bursæ.

Treatment.—Conservative treatment is indicated where there is a prospect of obtaining a good movable joint ; when, however, the articular surfaces become implicated, this is no longer practicable.

The conservative method consists in placing the limb in the best position—namely, extension, and, if necessary, keeping it extended by weights and pulley. It is then fixed in a Thomas's knee-splint, and Bier's hyperæmic treatment is adopted. As a rule, from six to twelve months will be required to completely cure the condition, but shorter periods are often sufficient. All pain should be relieved and flexion rectified before the splint is applied. It is well not to take the splint entirely off at once, but to accustom the patient to be without it by removal at night. If treatment by injection of iodoform is desired, the needle may be very simply introduced into the upper pouch of the synovial membrane. All early cases, especially in children, should be treated in the conservative manner.

Operative treatment is indicated when there are symptoms of destruction of articular surfaces, deformity or progressive disease, associated with bad general health which cannot be cured by conservative methods.

Arthrectomy.—When the patients are young (under fifteen), this operation may be adopted with a careful removal of the synovial membrane, and a very thin layer of the articular surfaces.

Excision.—This is indicated when the disease has progressed to the second or third stage, and in most patients over fifteen years of age. The ends of the bones are removed as well as the other tissues.

Amputation is indicated when the disease has recurred after excision, and, the general health becoming gradually worse, the spread of the disease to other parts is threatened.

Deformities resulting from Disease.—Bony ankylosis in a straight position is always aimed at, but it sometimes happens that, owing to neglect and insufficient treatment, deformity results. Usually the position is that of flexion and backward and outward displacement of the tibia with some eversion of the leg, while hyperextension is occasionally met with. If the contraction is due to soft tissues, they should be divided and weight and extension applied; and when osseous union takes place in a false position, cuneiform osteotomy may be performed. When the patient is still growing, the limb may be straightened by division of the femur above the joint.

Other Diseases of the Knee-Joint—Osteo-Arthritis and Rheumatoid Arthritis.—The former may be met with in one knee-joint alone or in both joints. The latter will be part of a general condition. The breaking off of a part of the lipping of the joint may account for the symptoms of a loose body.

If distension of the synovial membrane occurs, the fluid may be withdrawn. Foreign bodies may be removed by operation. If the disease be confined to one joint, it may be excised.

Charcot's Joint and other diseases are occasionally met with.

Pyogenic diseases of the joint usually result from infection through the blood-stream, or spread directly from adjacent bones. They may also result from traumatic injury through a penetrating wound.

The types met with are the acute arthritis of young children; suppuration of the joint associated with pyæmia; septic joint, owing to a penetrating wound; gonorrhœal and pneumococcal joints as a complication of these diseases; and serous synovitis, which usually results from direct spread of infection.

Treatment.—The joints should be immobilized in slight flexion, and Bier's hyperæmic treatment adopted; and if suppuration occurs, the joint should be opened and drained. It may be necessary to freely open the joint from side to side in order to stop the infection. If this fails, amputation may have to be performed.

ANKLE-JOINT.

Tuberculous Disease.—The disease may begin in the synovial membrane, and then shows the features of "white swelling," which fills up the hollows at either side of the tendo Achillis, and extends beneath the extensor tendons. There is wasting of the muscles in the calf of the limb, but there is little pain, and movements are more or less normal. When the disease spreads to the articular surface, however, pain increases rapidly, and normal movements cease.

When the disease begins in the bones, usually the astragalus, there is generally enlargement of one or other malleolus, with local pain and tenderness, or occasionally the sign first seen is the formation of an abscess, which is a common feature at some stage of disease of the ankle-joint.

If the disease of the tendons occurs apart from that of the ankle, the swelling is at the part principally affected.

Occasionally **sarcoma** simulates tuberculous disease, but the swelling is not so symmetrical.

Treatment.—Conservative treatment should be persevered with for a long period. The joint is immobilized with the foot at right angles

in a plaster of Paris splint, etc. When pain and abnormal position have been abolished, Thomas's knee-splint should be applied, and the patient got about without bearing any weight upon the affected joint. If this method fails, the diseased foci should be scraped away, and if this fails, the excision of one or more bones concerned in the disease should be carried out, and, if necessary, the whole of the astragalus, or other bones implicated, removed. Amputation is rarely called for, unless in adults suffering from a steadily progressing type or when excision has failed to cure it.

Other Affections of the Ankle.—The ankle-joint may be subject to **osteo-arthritis** and **pyogenic affections,** while **Charcot's disease** is fairly common, and is associated with the destruction of the bones of the ankle and the tarsus of a peculiarly rapid kind, accompanied frequently by perforating ulcer of the foot.

DISEASE OF THE TARSAL JOINTS.

Tuberculous disease is most usually met with, but they may also be affected with **osteo-arthritis, gout,** and **pyogenic affections.**

Tuberculous Disease.—The bones or the membrane may be first affected, and when the infection occurs in the joints, it should be remembered that there is a connection, between those of the astragalus, scaphoid, and the cuneiform, and the inner three metatarsal, and disease of one involves the others ; but the joints between the os calcis and cuboid, and the cuboid and two outer metatarsal, may be singly involved. There is some swelling over the joints which are affected. This may become diffused over the whole of the tarsus. When the bones are affected, there is marked tenderness over the lesion.

Treatment.—Conservative methods combined with good hygienic treatment should be persevered in, and where the disease is limited to one bone, or to one joint, this may be separately dealt with ; but as a rule, when operative treatment is employed, it is necessary to excise all the posterior tarsal bones, or to perform a Syme's amputation, the latter being employed when the general health is failing and septic sinuses prove incurable.

CHAPTER XIV

DEFORMITIES

Causes of deformity—General defects of stature and physique—Congenital deformities—Deformities due to general and local disease of bone, to disease of joints, and to disease of nerves—Deformities of the head, face, and mouth—Deformities of the spine (including developmental errors of the visceral clefts and arches)—Deformities of the upper limb—Deformities of the lower limb.

Deformities are either **congenital** or **acquired.** The acquired deformities are to a large extent preventable ; surgery, therefore, concerns itself with their prevention as well as with their correction.

Acquired Deformities result from injury or disease of the bones, joints, ligaments, muscles, or nerves. They may also be produced or modified by the factor of growth, and by mechanical strains, such as the body weight or the pull of certain muscle groups. **Disease or injury of bone** causes deformity by—(1) loss of the whole or part of a bone, (2) alteration in shape by curvature, or (3) alteration in the rate of growth. **Disease or injury of ligaments** produces deformity by—(1) loss of ligaments, with displacement ; (2) softening of ligaments, with displacement ; or (3) fibrosis around ligaments. **Disease or injury of muscles** produces deformity by—(1) actual loss of muscle, or paralysis ; (2) scarring and contraction, or loss of function of muscles. **Disease or injury of nerves** produces deformity by causing—(1) paralysis or (2) spasm of muscles. **Joints** become deformed by alteration of the bone-ends, of the ligaments, or of the muscles ; but in addition ankylosis of a joint should be considered a deformity. It may be bony, fibrous, or due to extra-articular adhesions. Finally, scarring of the skin or deeper tissues may produce deformity.

GENERAL DEFECTS OF STATURE AND PHYSIQUE.

Gigantism.—The whole skeleton and the muscles and soft parts are larger than normal. Giants are of rare occurrence. They are often weakly, and present curvatures of the spine and other deformities. In some cases the condition is ascribed to changes in the pituitary body.

Acromegaly.—A form of partial gigantism, in which the lower part of the face, especially the lower jaw, and the hands and feet, are enlarged. The muscles and subcutaneous tissue and skin over these parts are hypertrophied. To a less extent the whole skeleton may be enlarged, and the long bones show an excess of their normal curvatures. In the later stages a severe kyphosis usually develops, and the patient may become deaf and blind (optic atrophy). The pituitary

gland is always found enlarged, often containing a new growth. The disease usually arises in young adults, and may last twenty years or more. Extirpation of the pituitary body has been carried out.

Dwarfs.—If perfect in all their proportions, are called "true dwarfs." Most dwarfs, however, fall into one or other of the following classes :

Chondrodystrophia (Achondroplasia).—The defect is in the growth of the long bones at the epiphyseal cartilages. The basis cranii develops imperfectly in length, owing to premature synostosis of the basi-occipital and basisphenoid ; consequently, the antero-posterior diameter of the skull from nose to occiput is short, the bridge of the nose is depressed, and the calvarium appears unduly large. The body is well built, and of full size, but the upper and lower limbs are short, and the long bones curved. The hands are broad, short, and fat, and the terminal phalanges of the fingers do not touch each other when the hand is spread. All severities of chondrodystrophia occur from cases in which the limbs are almost entirely absent to cases in which there is a relatively slight diminution in growth of the long bones. In spite of the small size, these subjects are usually very muscular. Mental and sexual development is complete. Nothing is known as to the pathology of the condition, and no treatment is of any avail. Osteotomies may be done to improve deformities when these are severe.

Cretinism is that form of dwarfing which results from absence or loss of function of the thyroid gland. It differs from chondrodystrophia in that mental and sexual development do not occur. The child is short, fat, flabby, and the body and limbs are equally undeveloped. The muscular development is poor, the skin dry and coarse, and the hair thin. The deformities of the hands and of the head, characteristic of chondrodystrophia, do not occur.

The thyroid gland may be absent, or it may be present and even enlarged, but functionless. A similar condition may be due to atrophy of the gland after a specific fever in childhood, or to extirpation of the gland by operation.

The administration of thyroid extract in regular doses will always cause improvement, but whereas in a few cases the child becomes practically normal, in most the lack of development, especially of mental development, persists in a milder degree.

The Rickety Dwarf presents the features of the most severe form of rickets. The head is long, and the forehead high and square. The spine may be severely curved ; the femora are bowed forward and outward, the tibia forward, forward and inward, or forward and outward. Mental development proceeds, but is slow. Sexual development may be normal or delayed. In very severe cases an adult may measure only 3 feet 6 inches in height.

CONGENITAL DEFORMITIES.

Congenital deformities are divisible into two classes :

1. Those due to developmental defects.
2. Those due to disease or injury before birth.

Asymmetry in slight degree is not unusual—*e.g.*, one leg is often $\frac{1}{4}$ to $\frac{1}{2}$ inch longer than the other. More considerable asymmetry is due to either—

1. Gigantism of one limb, due usually to a diffuse lymphangioma or to overgrowth accompanying a diffuse cavernous nævus ; or

PLATE XLI.

ACHONDROPLASIA

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PLATE XLII.

RADIOGRAPH OF THE WRIST, FROM A CASE OF CONTINUED RICKETS.

The epiphyseal cartilage is widened in both directions, and the end of the diaphysis is cup-shaped.

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2. Dwarfing of one limb, either simple or more often with partial paralysis (as in hemiplegia).

Defect of a Segment of a limb—*e.g.*, of the thigh or of the upper arm—may occur with the rest of the limb perfect, or the rest of the limb may also be deformed

Congenital Constrictions, causing amputation or atrophy of the distal part of the limb, are not uncommon. These constrictions occur also round the trunk. They consist of scar tissue, and are due to the pressure of amniotic bands *in utero*.

Additions to Limbs occur only in the hands and feet in the shape of extra digits and bifid digits. An hereditary factor can often be traced.

Webbing occurs between fingers or toes, and also across the flexor aspects of joints, such as the elbow and shoulder.

Developmental deformities may further be due to absence or variation in size or shape of the bones (absence of clavicle, absence of one half of a vertebra), the presence of extra bones (cervical rib), and contracture of ligaments and muscles (club-foot),

Congenital Fractures may be single, in which case the lower end of the tibia is commonly affected, or multiple.

Congenital Dislocations are possibly primary developmental defects. Possibly they are due to dislocation, the result of intra-uterine pressure. Congenital dislocation of the hip-joint is common, of the shoulder-joint very rare.

DEFORMITIES DUE TO GENERAL DISEASES AFFECTING THE BONES.

Rickets.—The bone changes of rickets consist of—

1. Irregular formation of cartilage at the epiphyseal lines, leading to widening of this line and enlargement of the epiphyseal regions.
2. Delayed and defective ossification near the epiphyseal lines ; and
3. Defective ossification throughout the long bones.

The first two of these changes exceed the third in degree.

Deformities in rickets arise by the moulding of the softened bones by pressure. The pressure may be due to the weight of the body, as in the production of knock-knee, or it may be due to the weight of the limbs in certain habitual attitudes, as in the production of outward bowing of the tibiæ in a child who constantly sits in the cross-legged attitude ; or it may be due to atmospheric pressure, as in the production of depressions in the chest (Harrison's sulcus and vertical lateral sulci). Possibly muscular contraction may also assist in the production of rickety deformities.

The curvature of rickety bones may extend throughout their length, or may be limited to the neighbourhood of the epiphyseal lines.

During the recovery from rickets there is always a tendency for a thick buttress of bone to form along the concave side of the curve.

The regional deformities due to rickets are considered later.

Continued and Adolescent Rickets.—In certain cases active rickets with generalized bone changes persist into the adolescent period (continued rickets), and it is thought that occasionally these changes may commence during that period (adolescent rickets).

These cases are characterized by the presence of bone deformities of a progressive nature, with enlargement of the epiphyseal regions of the long bones, skiagraphs showing that the epiphyseal cartilage is

widened in both vertical and lateral directions. The patients are usually of small stature, and show the typical rickety conformation of the head.

Adolescent bone deformities, such as knock-knee, coxa vara, scoliosis, are best not classed with adolescent rickets, inasmuch as the deformities are single and local, and are not accompanied by general epiphyseal changes. It is clear, however, that in these cases also the ossification in the epiphyseal regions is not perfect, and the actual pathological changes in the bones are similar in nature to those in rickets.

Congenital Syphilis.—Bone deformities in congenital syphilis are due to a chronic osteo-periostitis. The tibiæ are most often affected. The whole of the shaft of the bone undergoes a thickening and overgrowth, the result of the chronic inflammation. The anterior part of the bone is affected more than the posterior, and increases in length ; consequently, the bone becomes bowed forward (*tibia en lame de sabre*). The condition arises in children aged eight to fourteen years, is usually symmetrical, and is diagnosed from rickety curvature by the evidence of inflammation, thickening, and curvature of the whole bone, and other evidence of congenital syphilis in the eyes, ears, teeth, facies, etc.

Osteomalacia.—The bone deformities are due to bending of the bones, the result of absorption of their earthy constituents. The stress of the disease usually falls on the pelvis, spine, and femora, so that severe pelvic deformity, lateral curvature of the spine, and bowing forward and outward of the femora, are the most characteristic deformities.

Osteitis Deformans.—The deformities are due to (1) gradual bending of bones softened by a chronic inflammation, as in bowing of the tibia ; (2) overgrowth in one of a pair of bones or in one side of a bone. The vault of the skull is enlarged, the facial region being unaffected. The spine becomes kyphotic ; the chest is flattened laterally ; the clavicle is thickened, and its curvatures increased ; the bones of the upper limb are usually little affected, but the humerus may show an increase of its normal curves, and the radius, from overgrowth in length, may be wrapped round the ulna (pronation deformity).

In the lower limb the femur and tibia both become convex forward and outward. These bones are usually the most severely affected.

Skiagraphs show enlargement of the bones, with rarefaction of the compact bone.

DEFORMITIES DUE TO LOCAL CHANGES IN BONES.

These may result from actual loss of substance of a bone by accident, or as the result of osteomyelitis, or they may result from partial or complete arrest of growth of a bone, or from excessive growth.

Arrest of Growth of Bones may follow—

1. A separation, partial or complete, of the epiphysis.
2. An acute inflammatory lesion of the epiphyseal region (acute septic epiphysitis).
3. It may occur as a congenital anomaly in association with the existence of multiple exostoses or enchondromata, and in rare deformities, such as congenital fracture of the tibia.

Overgrowth of Bone results from—

1. A chronic inflammatory process in the shaft of the bone, as in syphilitic osteitis.
2. A chronic inflammatory process in the neighbourhood of the epiphysis, as in chronic tuberculous osteitis in the neighbourhood of the knee.

Humphry's law as to the growth of bone was that a lesion in the neighbourhood of the epiphyseal line tends to cause arrest of growth of bone, and a lesion in the shaft tends to cause overgrowth of bone. It is incomplete in failing to take into account the excessive growth which occurs in chronic tuberculous osteitis in the neighbourhood of the epiphyseal lines.

Arrest of growth of a bone is usually partial—*i.e.*, the bone grows, but not at its normal rate. Complete arrest is very rare.

DEFORMITIES RESULTING FROM DISEASES OF THE JOINTS.

Fixation of a joint following disease may be due to—

1. Bony ankylosis.
2. Ankylosis by fibrous tissue.
3. Fixation by periarticular adhesions.

The final diagnosis of bony ankylosis can only be made by means of the skiagraph or by examination under an anæsthetic.

The best result after joint disease is a return of the ordinary movements of the joint. The next best is in most cases firm bony ankylosis in a good position. The small amount of movement allowed in fibrous ankylosis is often painful, of very little use, and it allows of the subsequent development of deformity by contracture. This is specially true in the lower limb, where bony ankylosis of a joint is always preferable to fibrous union. In the upper limb a movable joint is often better, even if strength is sacrificed.

In fixing joints which may become ankylosed, such as those infected with tubercle, each joint should be fixed in such a position as will be most useful should ankylosis occur.

The **Shoulder-Joint** should hang straight, with the forearm pointed a little in.

The **Elbow** should be placed at an angle of about 60°, the hand midway between pronation and supination.

The **Wrist** should be hyperextended.

The **Hip** should be slightly abducted, the foot pointing directly forward.

The **Knee** should be fully extended.

The **Ankle** should be at a right angle with the foot slightly inverted, so that the tread is on the outer border.

Bony Ankylosis in a faulty position is corrected either by osteotomy of the bone a short distance from the joint—*e.g.*, Gant's osteotomy—or by excision of the joint. The chief point to remember is the importance of leaving a movable joint in the upper limb, a fixed one in the lower. Therefore, excision with a view to leaving a movable joint is to be advised in the upper limb, excision with a view to securing bony ankylosis in the knee or ankle, and osteotomy in the case of the hip. Excision of the hip, as a rule, leaves a weak movable joint.

Fibrous Ankylosis is to be treated by the same measures or by forcible or gradual correction by pressure. In old tuberculous disease forcible correction may cause a recrudescence of the disease.

Fixation of a Joint by Periarticular Adhesions is to be treated by massage, active and passive movements, and hot-air baths.

Displacement at a joint may follow softening and destruction of the ligaments and destruction of the bone, being due to the persistent pull of the stronger muscles. It may be corrected by gradual or forcible manipulation, by osteotomy, or by excision, according to the nature of the adhesion between the joint surfaces.

Pathological Dislocation may follow sudden distension of the joint, as in the arthritis of typhoid and scarlet fevers, or destruction and absorption of the bone surfaces and ligaments, as in septic and tuberculous infection. The former variety should be prevented by tapping the joint. The treatment depends on the presence or absence of ankylosis.

DEFORMITIES DUE TO NERVOUS DISEASE.

These are of two sorts, according to the portion of the nervous system affected :

1. **Disease or Injury of the Upper Motor Neurone**—*i.e.*, cerebral cortex or pyramidal tract down to the termination of the neurone around the cells of the anterior cornu. This results in loss of control of the muscles supplied rather than paralysis. The muscles undergo a fixed contraction, with increase of reflexes. As a rule, the more powerful muscles overpower the weaker, and cause a deformity by their contraction. This deformity can, however, be undone by gradual pressure or by anæsthesia. Hemiplegia and spastic paraplegia are the commonest conditions causing such deformities. The electrical reactions of the muscles are unaltered.

2. **Disease or Injury of the Lower Motor Neurone**—*i.e.*, anterior cornual cells, anterior roots, or motor nerves. This results in a flaccid paralysis, the muscle being entirely paralyzed if the whole of its nerve is affected, or parts of it being paralyzed if only certain nerve fibres are affected. Deformities arise by the gradual shortening of muscles following loss of their opponents. The deformity is fixed, and cannot be undone by gradual pressure or by anæsthesia, forcible manipulations or division of tendons being necessary. The reflexes are lost if the muscles involved in them are affected. In the early stages paralyzed muscles show the reaction of degeneration, and later they fail to respond to any electrical stimulus.

Infantile paralysis, neuritis, and injury to nerves are the most common causes of this variety of paralytic deformity.

CONGENITAL DEFORMITIES OF THE HEAD.

Many irregularities in shape of the head are without significance. The most important pathological types are—

Hydrocephalus.—The calvarium is enlarged, so that the maximum circumference may be from 22 to 25 inches, or even more. The sutures are wide, and the fontanelles remain open late. The mental status is usually low, and there is often spasticity or inco-ordination of the limbs. The enlargement of the head is due to excessive size

of the ventricles, which is ascribed to disease of the ependyma with blocking of the proper channels of flow of the cerebro-spinal fluid.

Operative treatment aiming at the establishment of a permanent communication between the ventricles and the subarachnoid space, has been carried out, but has not proved very successful.

Microcephalus.—The calvarium is diminished in size, and its anterior part is narrowed. The sutures and fontanelles close prematurely; the mental condition is usually that of idiocy. Linear craniectomy—that is, the removal of a strip of skull cap along an antero-posterior line—has been performed many times, but has not resulted in much improvement. Probably the defective brain development is not due to the small size and lack of development of the skull, but the two conditions go together.

Achondroplasia.—Already described.

Oxycephaly.—The frontal region of the skull is flattened laterally and rises to a central peak. The skull, as a whole, is not unduly small, and the mental condition is good. There is usually exophthalmos, and a progressive optic atrophy ending in blindness occurs.

Cephalocele, a defect of a portion of the skull through which a protrusion occurs of the membranes (**meningocele**), or of the membranes and brain (**encephalocele**). If the portion of brain protruded includes an expansion of one of the ventricles, the condition is known as a **hydrencephalocele.** The protrusion usually occurs in the middle line in the occipital region, more rarely at the root of the nose, and in other situations.

The tumour may be of any size, and may be pedunculated. It is covered by skin, which may be thinned or may be nævoid. It swells up when the child cries. A meningocele is soft, fluctuating, translucent, and reducible by pressure. An encephalocele is non-fluctuating, opaque, pulsates, and is not reducible.

The prognosis in the case of large tumours is grave. The skin is liable to ulcerate, and septic meningitis may ensue.

Meningoceles may be treated by excision. Encephaloceles must be left alone and protected by a shield.

ACQUIRED DEFORMITIES OF THE HEAD.

Rickets.—The head is long in its antero-posterior diameter, the forehead high and square. It appears unduly large, but measurement shows that this appearance is fallacious.

Congenital Syphilis.—The frontal and parietal eminences are very prominent (Parrot's nodes) with linear depressions between (hot-cross bun head). Craniotabes, soft, unossified patches in the skull, are probably always due to congenital syphilis, although by some they are ascribed also to rickets.

CONGENITAL MALFORMATIONS OF THE FACE AND MOUTH.

Development.—In the early embryo the primitive mouth is surrounded by seven processes, which, by their development and union, form the face. Above, the mesial nasal process forms the nasal septum, and the lateral nasal processes the alæ of the nose. The maxillary processes grow inwards and form the cheeks and the greater

part of the upper lip and palate; but the mesial and lateral nasal processes project downward anteriorly, complete the central part of the lip, and form the premaxillary part of the upper jaw. The premaxilla thus formed consists of four segments, each bearing an incisor tooth. The mandibular processes unite below the mouth and form the lower jaw, lower lip, and chin.

Macrostoma, or transverse enlargement of the mouth, is due to failure of union between the maxillary and mandibular processes on one or both sides. It is very rare, and is easily remedied by a plastic operation.

Microstoma, or atresia oris, is more common, and is due to an excess of fusion between the maxillary and mandibular processes.

Facial Cleft is an extremely rare deformity, resulting from failure of union between the lateral nasal and maxillary processes. The cleft runs downwards from near the inner angle of the orbit, alongside the ala of the nose, to end in the mouth by splitting the upper lip. It involves the soft parts only.

FIG. 36.—METHOD OF PARING EDGES AND SUTURING IN SINGLE HARE-LIP.

Hare-Lip.—Median hare-lip is extremely rare.

Lateral hare-lip is due to imperfect coalescence of the processes which form the upper lip. Unilateral hare-lip may be incomplete—*i.e.*, a mere notch in the lip, or complete, the cleft extending upwards into the nostril. It is more common on the left side.

FIG. 37.—METHOD OF PARING EDGES AND SUTURING IN DOUBLE HARE-LIP.

Bilateral hare-lip consists of a similar fissure extending into each nostril. Any form of hare-lip may be associated with cleft palate, bilateral hare-lip being almost always so associated. Nothing is known of the causation of these deformities, which must therefore be put down as primary developmental defects. Occasionally they are hereditary.

Treatment.—The operative treatment of hare-lip should be undertaken as early as possible. It should always be completed before teething begins.

Under an anæsthetic the lip is first freed from the margin of the jaw sufficiently to allow the portion to come into apposition without tension. The margins of the cleft are then pared, and the skin and mucous membrane carefully sutured with horsehair or fine silkworm gut, great care being taken to bring the red margin of the lip carefully into line. The paring should be so carried out that after suturing the lip hangs down slightly at the point of union, subsequent contraction of the scar will slightly raise this point. The methods of paring are best shown by diagrams.

Cleft Palate.—Cleft palate is a malformation due to partial or complete failure of union of the palatal portions of the maxillary processes. The cleft may involve the uvula only (bifid uvula), or the soft palate, or the soft and part of the hard palate, or it may be complete. A complete cleft usually bifurcates anteriorly, so that the mesial premaxilla is left isolated, hanging from the nasal septum, or the cleft may deviate to one side, leaving the premaxilla attached to the opposite half of the jaw. The premaxillary segment usually carries the two central incisors; occasionally, however, four teeth are found in it. According to Albrecht, it represents that portion of the palate and upper lip which is formed by the mesial nasal process, and the cleft thus passes between mesial and lateral nasal processes. The nasal septum may project free into the cleft in the palate, or may be attached to one or other margin.

Cleft palate interferes less with swallowing than would be expected There is, however, a tendency for fluids to return through the nose Suction is interfered with, and artificial feeding has generally to be carried out from the first. With a little care this can be successfully carried out, but amongst the poor the death-rate of children with cleft palate is high, owing to difficulties in feeding.

Speech is nasal, and certain sounds in particular are ill-pronounced (*d*, *f*, *k*, *l*, *m*, *p*, *v*).

Treatment.—The best age at which to operate for cleft palate is still a matter of dispute. Most surgeons prefer to operate at two to three years (Ferguson, T. Smith, Berry), but Lane and Brophy, who use special methods, prefer to operate as early in life as possible. The points in favour of early operation are—

1. Nourishment is improved, as feeding is easier after the cleft is closed.
2. The teeth are not present.
3. The earlier the cleft is closed the greater is the improvement in speech.

The points in favour of delay are—

1. The early operation has a high mortality (12 per cent.).
2. The difficulty of feeding children with cleft palate has been exaggerated.
3. The ordinary operation is not possible in infants a few weeks old, and some special method has to be adopted which does not leave as flexible a soft palate. Consequently—
4. The voice is not as much improved by the early operation as has been claimed.

Langenbeck's Operation.—The child is anæsthetized and laid with the head hanging over the end of the table. A special gag (Smith's) is inserted. The edges of the cleft are first pared with a fine knife. Lateral incisions are then made on either side, parallel to the cleft, about half an inch from the alveolar margin of the jaw. A bridge

of mucous membrane and periosteum is raised from the palate by means of a curved raspatory inserted into those incisions, and the soft palate is separated from the bony palate by cutting with scissors. Sutures of silver wire or fine silkworm gut are inserted to close the cleft, and tied, starting with the posterior ones.

When applied to the hard palate, this operation is termed "uranoplasty," when the soft palate only has to be closed "staphylorrhaphy"; the raising of the muco-periosteal flaps is then unnecessary, but lateral incisions have usually to be made to relieve tension. When a separate premaxilla is present, it is generally removed. It may, however, be forced back into place after division of the nasal septum. The objection to this is that it often remains loose.

Lane's Operation consists in raising a flap of mucous membrane from one-half of the palate, turning it directly over to the other side, and suturing between the layers of the opposite side, which has been split to receive it. The side from which the flap is raised is left to heal by granulation.

Brophy's Operation consists in loosening the alveolar part of the jaw on either side, forcing the two together, and fixing them in place by lead plates. The edges of the cleft are scraped and left in contact. If they fail to unite, they are subsequently pared and sutured.

Lane's and Brophy's operations are usually done at the age of one to six months.

DEFORMITIES OF THE SPINE.

Normal Contour and Movements.—In the fœtus the spine shows backward convexities in the dorsal and in the sacral regions. As soon as the upright position is assumed, compensatory backward concavities arise in the cervical and lumbar regions. These curves increase slightly with growth

A slight lateral deviation of the spinous processes, to the left in the lumbar region or to the right in the dorsal region, is extremely common.

Flexion and extension of the spine occur chiefly in the lower dorsal and lumbar regions, and in the cervical region. Lateral flexion also occurs in these regions, and is always accompanied by rotation of the vertebral bodies towards the convex side. Rotatory movements occur chiefly in the cervical region. The upper dorsal region possesses very little movement. Nodding movement takes place at the occipito-atlantal and rotatory movement at the atlanto-axial joints.

Congenital Deformities of the Spine.

Spina Bifida is a failure of closure of the neural arches of the vertebræ. It is commonest in the lumbo-sacral region, much more rare in the cervical region. Very rarely it involves the whole spine.

Varieties—Spina Bifida Occulta.—There is no protrusion of the spinal cord or its membranes. The defect is usually in the lumbo-sacral region, and its situation is marked by a dimple, a lipoma, or a tuft of hair. There may be involvement of the nerves of the cauda equina.

A **Meningocele** consists in a protrusion of the meninges only.

A **Meningo-Myelocele** consists of a protrusion of the membranes, with the spinal cord or cauda equina running down in the posterior wall of the sac. These are the two commonest forms.

A **Syringo-Myelocele** consists of a dilatation of the central canal of the cord, so that a portion of the spinal cord is spread out over the posterior wall of the sac.

In a **Myelocele** there is a failure of closure of the medullary groove, so that the central canal of the cord lies open upon the surface. This form is very rare, and the children are usually stillborn.

With the exception of the first and last named varieties, a spina bifida forms a tumour in the middle line of the back, covered with skin, which may be normal or thinned. It is fluid, and presents an impulse on crying. The defect in the neural arches of the vertebræ can be felt.

Associated deformities are frequent, especially hydrocephalus and congenital talipes.

The presence of nerve elements in the sac may be indicated by the existence of an opaque shadow in the posterior part on trans-illumination, by the existence of a vertical groove, or by the occurrence of paralysis or trophic disturbances in the lower limbs.

Treatment.—The injection of Morton's fluid (iodine, gr. 10; potassium iodide, gr. 30; glycerin, 1 oz.) into the sac is the most successful form of treatment in meningocele. The inflammatory reaction results in cicatrization of the sac. More than one injection may be necessary.

Excision of the sac is the most rational procedure, but is a very fatal operation in infants, and is better postponed if possible. Nerve elements, if present, must be carefully dissected away.

In cases of large tumours, where nerve elements are almost certainly present, and where the skin is ulcerated, the sac should be simply protected by a shield.

Many children with spina bifida die as the result of ulceration of the skin, rupture of the sac, and septic meningitis.

Variations of the Vertebræ are of two sorts. Occasionally an extra half vertebræ occurs on one side in the lumbar region, and gives rise to a congenital scoliosis. More frequently the last cervical vertebra bears a rib, or the fifth lumbar vertebra is fused with the sacrum.

Deformities due to Inflammatory Disease of the Spine.

Acute Spondylitis may be due to staphylococcal, streptococcal, typhoid, or gonococcal infection. It is very rare, and if the patient survives, leaves little deformity but much rigidity. Gonorrhœal infection is a possible cause of spondylitis deformans.

Chronic Tuberculous Spondylitis (Spinal Caries, Pott's Disease).—Spinal caries is a tuberculous infection of the vertebræ. In the large majority of cases the disease commences in the anterior part of the vertebral bodies; very occasionally, in the cervical region, the laminæ are first affected.

In the common form there is a rarefying tuberculous osteitis extending through the bodies of several adjacent vertebræ, which are thus softened and fall together. By this means a sharp angle pointing backwards is produced in the affected region of the spine. This angular deformity is, however, not a necessary accompaniment of spinal caries. It should be possible to diagnose the disease before such deformity arises, and then, by appropriate treatment, to prevent its occurrence. The angular projection is greatest when the upper

dorsal region is affected. It is late in origin and slight in degree in the cervical and lumbar regions.

Angular curvature, when it has once arisen, is only capable of correction to a very limited extent. In the early stages continuous hyperextension of the spine upon a suitable frame will undo part of the deformity, and mask the rest by producing compensatory curves above and below. In the later stages bony ankylosis will have occurred between the affected vertebræ, and correction should not be attempted. Forcible correction of such well-established curvatures has been carried out (Calot's operation), but the results are disastrous, the disease being often lit up locally in the spine, or disseminated

Fig 38.—Spinal Caries in Upper Dorsal Region: Characteristic Attitude. (Young, "Orthopædic Surgery.")

Other deformities in spinal caries are compensatory or symptomatic. The compensatory curvatures consist of a flattening of the normal backward convexity in the dorsal region, or of an increase in the normal lumbar and cervical concavities. Occasionally the carious process affects one side of the vertebræ more than the other, so as to give a lateral tilt to the spine above. A compensatory lateral curvature will then arise, which is, in fact, a true scoliosis, and can only be distinguished from a primary scoliosis by the discovery of the angular projection at one part of the curve, by the presence of rigidity, and by means of a skiagram.

The symptomatic deformities in spinal caries are various, and are due to muscular spasm. The most common are—

PLATE XLIII.

SEVERE FIXED KYPHOSIS WITH COMPENSATORY LORDOSIS IN AN ADOLESCENT.

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Disease in the Cervical and Cervico-Dorsal Regions.—(1) Torticollis ; (2) increase in the normal backward concavity of the cervical spine ; (3) ; elevation of the shoulders.

Disease in the Dorsal Region.—(1) Elevation of the shoulders ; (2) a forward tilt of the whole body ; (3) a lateral tilt of the body, due to spasm in one psoas muscle.

Disease in the Lumbar Region.—As in the dorsal region, (2) and (3), and occasionally (4) lordosis.

Spondylitis Deformans (Osteo-Arthritis of the Spine).—An affection usually of adults, in which a progressive kyphosis is accompanied by loss of movement in the spine. The ordinary changes of osteo-arthritis, with abundant formation of osteophytes, take place in the spinal articulations, and, in addition, the bodies of the vertebræ become united anteriorly by newly formed bone.

The early provision of a spinal support will lessen the resulting deformity and relieve the pain, but the resulting rigidity is not capable of alleviation.

Static Deformities of the Spine.

These include variations of the antero-posterior curvatures and lateral curvature of the spine.

Kyphosis is an undue increase in degree or extent of the normal dorsal curve.

It may be the result of certain definite diseases : spinal caries, spondylitis deformans, osteitis deformans, rickets, or very rarely of syphilis. It is more commonly due to muscular weakness or habitual posture. As a result of muscular weakness, it may occur in tabes, Friedreich's ataxia, progressive muscular atrophy, and other nervous diseases.

Postural kyphosis is common amongst children and adolescents. Myopia, deafness, adenoids, and habitual attitudes in school or at work are important causes. It must be remembered, however, that a moderate degree of kyphosis is often a natural peculiarity, and is common in heavily built, muscular persons.

In older persons the kyphotic curve becomes to some extent fixed, and is corrected by an increase in the lumbar concavity (kypho-lordosis). Secondarily, the chest becomes flat and its expansion poor, the abdomen prominent, and the head droops forwards.

Treatment is by suitable exercises to strengthen the extensor muscles of the spine, and correction of such causes as myopia, adenoids, and habitual posture. In young people the improvement should be great.

Lordosis is an undue increase in the degree of the lumbar concavity. It is usually secondary to (1) flexion deformity of the hips, as in congenital dislocation ; (2) anterior convexity of the shafts of the femora in rickets ; (3) kyphosis ; (4) paralysis of the glutei ; (5) abdominal distension, as in pregnancy. It also occurs in spondylolisthesis (displacement forward of the last lumbar vertebra on the sacrum), which may be a congenital deformity.

Treatment is that of the primary condition.

Lateral Curvature of the Spine (Scoliosis).—An habitual or fixed deformity, in which the whole of the spine, or a part of it, is deviated to one side of the middle line. A simple lateral deviation occurs constantly in certain attitudes, and is not pathological, unless it is habitual or fixed.

Lateral curvature may be—

1. **Congenital,** due to a defect of one of the vertebræ.
2. **Rachitic,** or very rarely due to some other disease which causes softening of the bones—*e.g.*, osteomalacia, osteitis deformans.
3. **Secondary** to shortening of one leg, to torticollis, or to fibrosis of one lung after empyema or pleurisy.
4. **Paralytic,** due to paralysis of the spinal muscles, most often after an attack of anterior poliomyelitis.
5. **Adolescent,** in which none of these causes is present.
6. **Functional.**

Several varieties of lateral curvature occur, and each of these causes gives rise to a particular variety of curve.

Lateral flexion of the spine is invariably accompanied by a rotation of the vertebræ involved—*i.e.*, the bodies of these vertebræ deviate more towards the convex side than do the spinous processes; consequently the transverse processes point backward instead of directly to the side, and the erector spinæ muscle and ribs are rendered more prominent posteriorly on the convex side than they are upon the concave.

In the slighter degrees of lateral curvature, with a single curve, this rotation of the vertebræ is so slight as to be scarcely visible, and on full flexion of the spine, or on suspension, the whole of the curvature disappears.

In the more severe degrees, with double or triple curves, the rotation is more marked, and in most cases the curve and the prominence of the erector spinæ or ribs are still visible on full flexion or on suspension; in fact, full flexion of the spine may render the curve more clearly visible.

Single Curves (C curves) may be "total"—*i.e.*, involve the whole length of the spine—or may be short curves in the lumbar region. They are much more often convex toward the left. This is the form of curve which is secondary to a short leg, to adduction of the hip, or to torticollis. It also occurs in functional deformity of the spine, and is common in school-children as the result of habitual posture. In the common single curve to the left, the right hip becomes more prominent, and the left shoulder is raised.

Double Curves (S curves) are most often convex to the left in the lumbar, to the right in the dorsal region. This is the usual form in true adolescent scoliosis. The right hip is prominent, and the right shoulder high; and if there is much rotation of the vertebræ, the ribs on the right are prominent posteriorly, flattened anteriorly; those on the left are prominent anteriorly, flattened posteriorly.

In **Congenital Scoliosis** there is most often a primary lumbar curve, due to asymmetry of one of the lumbar vertebræ, with a secondary curve in the opposite direction in the dorsal region. The diagnosis must be made by means of a radiograph.

In **Rickety Scoliosis** there is usually a curve to the left in the dorso-lumbar region, and a compensatory curve to the right in the upper dorsal region. The curvatures are often severe, and rotation of the vertebral bodies may be extreme.

Paralytic Scoliosis is usually due to anterior poliomyelitis affecting the erector spinæ or psoas muscles. In it also there may be severe rotation of the vertebral bodies.

Adolescent Scoliosis may arise at any time during the growing period, and is much more common in girls than in boys.

PLATE XLIV.

ADOLESCENT SCOLIOSIS.

Right dorsal, left lumbar convexities, with much rotation of the Vertebræ.

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It is ascribed to various causes :

1. Habitual posture in standing, sitting, or lying.
2. Muscular weakness, general or local.
3. Weakness of the spinal ligaments.
4. Undue softness of the vertebræ themselves.

Of these the first is undoubtedly important in regulating the nature of the curve, but will not by itself give rise to a severe curvature. In the case of progressive adolescent scoliosis, with double or triple curves, there must be some local cause in the shape of unequal muscular power on the two sides, weakness of ligaments, or softness of the vertebræ. But the actual nature of the defect is not usually ascertainable.

Examination.—The patient must always be stripped to the waist, and the boots removed. She should be examined standing, hanging, and stooping. The neck and chest must be examined from the front, the lower limbs measured, and other static deformities (flat-foot and knock-knee) looked for.

Treatment of Scoliosis.—1. Any primary cause must first be corrected if possible—*e.g.*, torticollis, short leg, etc.

2. Habitual postures must be corrected, postures of standing, sitting at work or in school, etc., and lying all being remembered. In many cases all work must be stopped, and rest on the back upon a flat reclining board for several hours a day ordered.

3. Exercises and massage of the spinal muscles are in most cases essential. The exercises are—(1) Postural, aiming at securing good, habitual standing, sitting, and lying postures ; (2) stretching, aiming at straightening out the curves by active or forced movements ; (3) strengthening, aiming at improving the tone and strength of muscles which are being overcome by their opponents.

4. In certain cases a spinal support is necessary. This may be of plaster of Paris, of poroplastic felt, or of steel. It must in every case have a good hold upon the pelvis as a basis of support, and, as a rule, it should be fitted in the suspended position.

Supports are necessary in most paralytic and severe rickety cases, and in adolescent scoliosis which increases in spite of treatment by rest and exercises, or in which proper rest cannot be secured.

Prognosis.—The degree of possible improvement can usually be seen by suspension of the patient. Curvatures which do not disappear upon suspension are not, as a rule, capable of correction. In practically every case, however, by proper treatment all pain can be relieved, the chest expansion can be improved, and the shoulders rendered level. The deformity does not as a rule increase after growth is complete.

DEFORMITIES OF THE NECK.

Congenital Abnormalities.

Developmental Errors of the Visceral Clefts and Arches.—In the early embryo the primitive pharynx shows on either side four protrusions, which have each a corresponding depression upon the surface. These represent the first four visceral clefts of fishes. In the human embryo, however, they do not at any stage communicate with the exterior. These clefts are separated from each other and from the mouth by five bars or visceral arches, of which the first three and

possibly the fourth contain cartilage. Certain parts of these cartilages persist, the structures enumerated below being formed from them :

	Proximal Part.	Intermediate Part.	Ventral Part.
1. Mandibular or Meckel's cartilage	Malleus ? Incus	Disappears —	Part of lower jaw. —
2. Hyoid cartilage ..	? Incus ? Stapes Styloid process	Stylohyal ligament Lesser cornu of hyoid	Body of hyoid.
3. Thyrohyoid cartilage..	Disappears	Great cornu of hyoid	

4. Fourth cartilage possibly forms the thyroid cartilage.

From the first cleft is developed the Eustachian tube and middle ear ; the second cleft is represented by the tonsillar region and supra-tonsillar recess ; the other clefts disappear.

The middle and anterior part of the tongue grows from a mass in the ventral wall of the pharynx between the mandibular and hyoid bars (tuberculum impar). The lateral parts of the tongue grow forward on either side of this from the ventral parts of the second and third visceral arches. They fuse with the tuberculum impar, but centrally in the line of fusion a depression is left—the foramen cæcum.

The middle lobe of the thyroid gland develops as a pouch from the region of this foramen cæcum. For a time it is connected with this foramen by a tubular duct, which, however, normally disappears. The lateral lobes of the thyroid develop as protrusions from the fourth visceral arch. The thymus develops in two lobes as protrusions from the third visceral arch.

The pinna is formed from a number of prominences on the mandibular and hyoid arches which surround the opening of the first visceral cleft, and probably represent the operculum of fishes. The tragus and helix grow from the mandibular arch, the antihelix, antitragus, and lobule from the hyoid arch.

The primitive mouth (stomodæum) and the prominence formed by the heart are at first very close together, there being no neck, and the visceral clefts being crowded together. The neck develops by the retreat of the heart downwards, and in the process the external openings or rudiments of the visceral clefts and those structures which have developed from them—*e.g.*, the thyroid and thymus glands—are drawn downwards, whilst the internal openings of the clefts remain high up in the pharynx. The line of the external openings of the visceral clefts extends along the anterior border of the sterno-mastoid from the external ear to the root of the neck.

Cervical Fistulæ.

Median Cervical Fistula is a rare condition resulting from persistence of the lower part of the thyroglossal duct. The fistula is not present at birth, but is formed by the opening or bursting of an abscess produced by suppuration in the persistent duct. It usually opens at about the level of the cricoid cartilage, and can be traced up to the hyoid bone. Here it continues up as a fibrous cord in front of or behind this bone, and thence as a cord or duct to the foramen cæcum. As these fistulæ have often been treated by opening and scraping, their orifices are usually much puckered and scarred. To effect a cure, the entire tract must be dissected out.

Lateral Cervical Fistula is due to a persistent branchial cleft. The external opening is somewhere along the line of the anterior border of the sterno-mastoid muscle. The tract extends upwards in the neck between the bifurcation of the carotid, over the superior laryngeal nerve, and ends, if complete, by opening into some part of the pharynx. Usually the lower part of the fistula is the largest ; the upper part may be incomplete or may not open into the pharynx. These fistulæ are generally present from birth ; their removal may necessitate an extensive and difficult dissection.

Cervical Dermoids.

In addition to ordinary middle-line dermoids, cysts arise in the neck from remnants of the thyroglossal duct and branchial clefts.

Thyroglossal Dermoids occur (1) on the dorsum of the tongue near the foramen cæcum ; (2) in the substance of the tongue between the genio-hyoglossi ; (3) in the neck in front of the thyroid and cricoid cartilages. Those in the first two situations are usually ordinary dermoids lined with stratified epithelium, and containing sebaceous material ; those in the neck are lined with ciliated epithelium.

Branchial Dermoids occur usually in the anterior triangle immediately below the angle of the jaw. They are lined with stratified epithelium, outside which is a thick layer of lymphoid tissue. Cervical dermoids are easily dissected out.

Accessory Thyroids.—Accessory masses of thyroid tissue occur along the line of the thyroglossal duct either in the tongue or in the neck. Their occurrence in the tongue is extremely rare. Lateral accessory thyroids occur in the neck above the lateral lobes of the thyroid, usually opposite the hyoid bone. They are not very uncommon, often multiple, and are usually mistaken for enlarged glands, and removed as such.

Accessory Auricles.—These occur as tags of skin, which may contain cartilage, along the line of the anterior border of the sterno-mastoid. They are often symmetrical, and may occur in families. These cervical auricles are particularly common in some animals—*e.g.*, goats. They probably represent persistent opercular tubercles belonging to the branchial clefts.

Accessory Tragus in front of the natural tragus is not very uncommon. Several may be present.

Cervical Spina Bifida is extremely rare.

Cervical Rib—*i.e.*, a rib attached to the anterior transverse process of the seventh cervical vertebra—although doubtless congenital, does not usually produce symptoms until adult life is reached. Most often the symptoms are numbness down the inner side of the arm and paresis of the intrinsic muscles of the hand, indicating pressure upon the lower trunk of the brachial plexus. Occasionally the subclavian artery which arches over the adventitious rib is compressed, and gangrene of the tips of the fingers may occur. The diagnosis must always be made by means of a skiagraph. Removal of the rib is difficult, but gives good results. The condition is often bilateral.

Acquired Deformities.

Torticollis, or wryneck, may be due to muscular spasm (symptomatic), or to muscular contraction, or to displacement of vertebræ (traumatic).

Acute Torticollis is due to an acute myositis, with spasm of the affected muscles (sterno-mastoid), usually ascribed to rheumatism.

Secondary Torticollis is due to muscular spasm as a result of inflamed cervical glands or of cervical spinal caries.

Traumatic Torticollis results from subluxation occurring between two of the cervical vertebræ on one side. This may occur from very slight injury.

Very occasionally torticollis may be due to variations in the cervical vertebræ, to alterations in these vertebræ as the result of tuberculous or other inflammatory disease of the spine, or to a cervical curve in scoliosis.

Congenital Torticollis, so called, is a lateral deformity of the cervical spine, due to shortening of one sterno-mastoid muscle. It is usually discovered in children several years of age. There may be a history that after birth a tumour was found in the sterno-mastoid muscle, a hæmatoma due to partial rupture.

The chin is tilted upwards forwards, and away from the contracted muscle, and the whole head is displaced toward the opposite shoulder. There is a lateral curvature of the spine concave toward the contracted muscle in the cervical region, with a secondary curve in the opposite direction in the lower dorsal region. The face is usually asymmetrical, being smaller on the affected side.

Treatment is by tenotomy of both heads of the sterno-mastoid muscle near their lower attachment. This may be carried out subcutaneously, but is usually done by an open incision, the anterior and internal jugular veins being so close to the muscle as to be liable to injury. After-treatment must be carried out for at least three months, and consists of either daily manipulations and exercises, or over-correction in plaster of Paris or some form of apparatus.

In some cases of torticollis contractions of muscles other than the sterno-mastoid are present—*e.g.*, the splenius.

Spasmodic Torticollis is a nervous disease characterized by tonic and clonic contractions of the cervical muscles, there being a fixed deformity, due to the tonic spasm, in addition to the irregular clonic movements ; the latter may be accompanied by severe pain. During sleep the spasm disappears. The pathology is unknown.

Treatment is carried out by educational exercises, high-frequency currents, and the use of nervous depressants. In resistant cases neurectomy of the spinal accessory nerve or of the posterior divisions of the cervical nerves may be carried out.

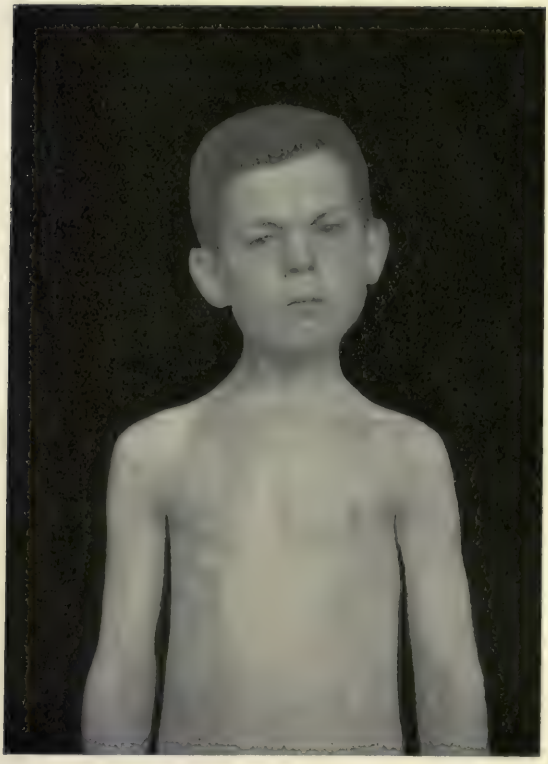
DEFORMITIES OF THE UPPER LIMB.

Congenital Deformities.

Absence of the Clavicle is rare ; it may be complete or partial, unilateral or bilateral, and is sometimes associated with defective ossification of the vault of the skull (cranio-cleidodystosis). There is very little disability.

Congenital Elevation of the Scapula (Sprengel's Shoulder). — The scapula is small, is situated higher than on the sound side, and its vertebral border is tethered to the spine, so that rotation is impossible, and the arm cannot be fully elevated. There is a lateral curve of the

PLATE XLV.



TORTICOLLIS, DUE TO CONTRACTION OF THE RIGHT STERNO-MASTOID MUSCLE.

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spine towards the deformed scapula, and the chest is flattened laterally on the affected side. There is often some abnormality of the ribs—*e.g.*, bifurcation—and sometimes a bony process unites the spine to the scapula. The disability is slight, and may be rendered less by remedial exercises.

Congenital Dislocation of the Shoulder is very rare. Some forward luxations of the shoulder should apparently be classed as such, but most of these cases are instances of Erb's palsy.

Club-Hand is of two principal varieties :

1. Absence of the radius or of its lower end, with curvature of the ulna at its lower end, radial deflection of the hand, and often absence of the thumb.

2. The forearm bones are perfect, but the wrist and fingers are flexed and deflected to the ulnar side, and the thumb adducted into the palm.

Deflection of the hand or fingers in other directions is excessively rare.

Club-hand is to be treated by manipulations, and by the use of an apparatus to replace the missing radius. Splitting the ulna and implanting it into the two sides of the carpus has not been successful.

Polydactylism (supernumerary digits) is often a family peculiarity. Such digits as are unsightly or of no use should be removed.

Absence of Fingers occurs with absence of the radius, as a result of congenital constructions, and in the "lobster-claw" deformity, in which the hand is split, and there are only two large digits. This last may be a family peculiarity.

Macrodactyly, or giant finger, may be congenital, or may arise as the accompaniment of a diffuse lymphangioma or of a plexiform neuroma. If the digit is in the way, it must be amputated.

Syndactyly (webbing) may be close, the phalanges lying fixed, close together, or open, separated by a flat web.

A plastic operation is required, and should be preferably performed at the age of four or five years.

Congenital Contractions of the Fingers are rare. The most common is flexion of the little finger, slight degrees of which occur as a family peculiarity. Manipulations in childhood should suffice to cure.

Defective Growth of Bones of the Upper Limb.

Arrest of Growth of the Upper End of the Humerus is not uncommon after epiphysitis ; it leads to shortening, but no deformity, and requires no treatment.

Arrest of Growth of the Inner Side of the Lower Epiphysis of the Humerus is one of the causes of cubitus varus. In the natural elbow the forearm makes an angle of 170 degrees, opening outwards with the arm (carrying angle). In cubitus varus this angle is diminished or reversed ; in cubitus valgus it is increased. These deformities are usually due to malunion of fractures of the lower end of the humerus, but occasionally cubitus varus arises gradually after an injury to the lower epiphyseal region of the humerus, and is due to arrest of growth of the inner part of the epiphyseal line.

If either deformity causes any inconvenience, it can be corrected by an osteotomy of the lower end of the shaft of the humerus.

Arrest of Growth of the Lower End of the Radius may follow injury or epiphysitis ; it usually results in radial deflection of the hand, the

ulna projecting downwards on the postero-internal aspect of the wrist.

Spontaneous Subluxation of the Wrist (Madelung's Deformity) consists in a twisting forward of the lower end of the radius, carrying with it the hand and wrist. The ulna remains as a prominence posteriorly. The radial styloid process is at a higher level than that of the ulna. The deformity arises spontaneously in adolescents who use the wrist much—*e.g.*, washerwomen—and is probably due to alteration in growth of the lower radial epiphysis from repeated strains.

Arrest of Growth of the Ulna is rare, but occasionally exists as a congenital deformity, or arises in cases of multiple exostoses, or after epiphysitis. Usually the lower end of the ulna is left behind in the forearm, the wrist being carried down with the radius. Occasionally the radius may become bowed, or its upper end dislocated forwards.

Paralytic Deformities of the Arm.

Infantile Paralysis affects the upper limbs much more rarely than the lower; it does not tend to produce fixed deformities, and very little can be done by surgical means. In occasional cases, however, there is a useful forearm and hand, but the shoulder or elbow are flail from loss of their muscles. The shoulder may then be fixed by arthrodesis, and the elbow can be kept in the most useful (flexed) position by excision of a diamond-shaped portion of skin from the anterior surface (Jones).

Spastic Paralysis in severe cases results in flexion of the elbow, pronation of the forearm, and flexion of the wrist, all due to persistent contraction of spastic muscles. Jones and Tubby's operation consists in the transplantation of the insertion of the pronator radii teres to the back of the radius and of the flexor carpi radialis and flexor carpi ulnaris to the back of the wrist—an attempt to undo the persistent pronation and flexion.

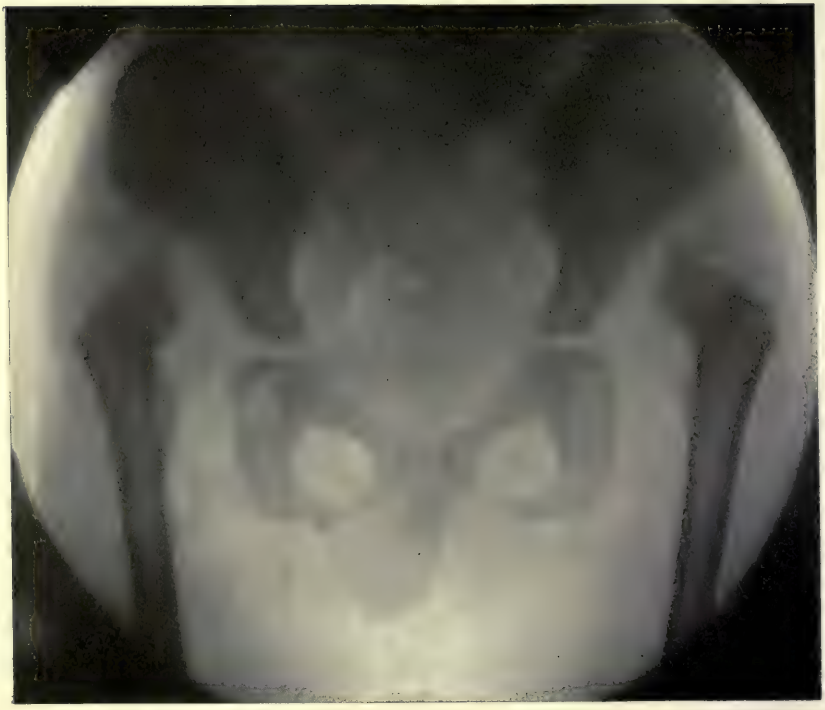
Erb's Paralysis, or **Obstetrical Paralysis,** is due to a partial or complete rupture of the upper trunk of the brachial plexus occurring during delivery. The spinati, deltoid, biceps, brachialis anticus, and supinators, are paralyzed, and the arm takes up a characteristic hanging position, with the elbow extended, the forearm pronated, and the whole limb rotated inwards. In severe cases the shoulder may be dislocated backwards by the unopposed action of the pectoralis major, and such cases are not uncommonly diagnosed as congenital dislocations of the shoulder-joint.

In the early stages treatment by massage and movement will usually result in much improvement. If, however, the condition does not improve, an attempt may be made to suture the ruptured trunk; but the results of this operation are not good.

A similar paralysis may occur in later life as the result of injury to the shoulder region.

Ischæmic Paralysis (Volkmann's Paralysis) is a form of paralysis which follows the application of tight splints to the arm and forearm, usually after fracture of the lower end of the humerus in children. No special nerves or muscles are paralyzed, but all the muscles atrophy; the hand takes up a position of flexion at the wrist, with hyperextension of the metacarpo-phalangeal and flexion of the interphalangeal joints (claw-hand). The fingers are blue and cold. Treatment may be carried out by (1) gradual correction by manipulations and

PLATE XLVI.



Double Congenital Dislocation of Both Hip-Joints, showing Deficient Acetabula, and Upward Displacement of Heads of Femora.

(Photo by Dr. Bowker.)

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splints, (2) lengthening the flexor tendons, or (3) excision of a portion of the radius and ulna.

Drop Finger, or **Mallet Finger,** is a flexion of the terminal phalanx of a finger, due to partial or complete rupture of the extensor tendon near its final insertion. It is produced by forced flexion of the terminal phalanx, usually by a blow. Recovery usually takes place if the joint is kept extended by a splint for a few weeks

Trigger Finger is a condition in which one of the interphalangeal joints can only be flexed or extended by a sudden effort, the movement occurring with a click. The exact cause is not known.

Dupuytren's Contraction is a contraction of the palmar fascia, usually occurring in middle-aged men. It is due to a chronic inflammation of the fascia resulting from gout, trauma, or occupation. The fourth and fifth fingers become flexed into the palm, which is thickened, puckered, and pitted.

Treatment is carried out by subcutaneous division of the tight bands, or by dissecting them out, the fingers being subsequently retained in position by a suitable splint.

DEFORMITIES OF THE LOWER LIMB.

Congenital Deformities.

Congenital Dislocation of the Hip-Joint is one of the commonest congenital deformities. It is seven times more frequent in girls than in boys, and is most often unilateral, the proportion of unilateral to bilateral cases being three to one.

The head of the femur is displaced and lies either—

1. Posteriorly on the dorsum ilii, or

2. Anteriorly, immediately under the anterior superior iliac spine.

The posterior dislocation is the common one, the anterior is very rare.

The acetabulum is in the normal situation, and in infancy is well formed. It fails, however, to increase in size with age, so that in a child of seven or eight it is inadequate to contain the head. The head of the femur lies in an extension of the capsular ligament. In older children a false acetabulum is formed opposite the head of the femur.

Symptoms and Signs.—In unilateral cases there is a limp, the spine becomes convex in the lumbar region towards the affected side, and the lumbar concavity is increased (lordosis). Movements of the joint are free, and on drawing upon the foot the head of the femur can be pulled down, and the limb thus lengthened (telescopic movement). In older children the hip becomes more fixed, telescopic movement is lost, and abduction may be limited.

In bilateral cases there is much lordosis and a characteristic waddling gait. In anterior dislocations lordosis is absent. In all cases there is a hollow over the region of the hip-joint anteriorly, and the head of the femur can be felt in its abnormal position.

The **Diagnosis** has to be made from tuberculous disease and from coxa vara by—

1. The history dating from birth or from the time the child first walked.

2. The absence of pain.

3. The absence of limitation of movement.

4. The palpation of the head of the femur in its abnormal position.

Treatment.—Attempts should always be made to replace the head of the femur in the acetabulum by manipulation (Lorenz's operation). This consists of the following stages:

1. Rupture of the adductor muscles by beating them with the hand, the hip being fully flexed and abducted.

2. Stretching the hamstrings by full flexion of the hip with extension of the knee.

3. Stretching the structures in front of the joint by hyperextension of the hip.

4. Levering the head into the acetabulum by full flexion and forcible abduction of the hip, the closed fist being placed behind the great trochanter to lever the head forwards. An audible click occurs as the head slips into place.

5. Fixation in plaster of Paris in this flexed and abducted position.

6. The subsequent application of fresh plasters, each in a more extended and adducted position, until the limb lies vertical. The period of application of plasters is about nine to eighteen months.

The best age for performing the operation is one to four years. Unilateral cases may be treated up to the age of eight, bilateral cases up to the age of seven. There is a fair chance of successful reposition in suitable cases. Those in which successful reposition does not occur are usually converted into anterior dislocations, and thereby greatly improved.

In older children open operations may be performed, but are not likely to result in anatomical cure.

Congenital Fracture of the Tibia.—A rare deformity in which the tibia presents an acute angle forwards in its lower third. There is usually shortening of the limb, absence of the lower part, or of the whole of the fibula and of the little toe, and a dimple in the skin over the angle in the tibia.

Occasionally an ununited fracture occurs at the site of the angle in the tibia. In these cases all attempts to secure union usually fail, and amputation has to be performed. In cases with union the condition can be improved by an osteotomy of the tibia, and the subsequent application of an instrument.

Congenital Talipes is considered under Deformities of the Foot.

Deformities Resulting from Bone Disease.

Rickets.—The common deformities of the lower limb are—

1. Curvature of the femur convex outward, or forward and outward, usually in the middle and lower part of the shaft.

2. Depression of the neck of the femur (rickety coxa vara). This occurs only in cases of continued rickets, as at the age of one to two years the femoral neck is cartilaginous.

3. Genu valgum.

4. Curvature of the tibia—(1) Convex outward in its whole length; (2) convex forward usually in the lower half; (3) convex inward; or combinations of these.

Genu varum is produced by an outward convexity of both femur and tibia.

The **Treatment** of these rickety deformities is—

1. Up to the age of four years by splints, which may be applied either (1) long, reaching beyond the feet to prevent the child walking; (2) short, on the concave side of the curve, and bandaged tightly to pull the bone straight.

2. At four to five years by osteoclasis—*i.e.*, fracture of the bone. This is to be advised for curved tibia, which is not improving at four years, and is carried out by bending with the hands over a wedge, or by an osteoclast. Fixation in splints or plaster is carried out for four weeks.

3. Osteotomy in children over five years.

McEwen's Osteotomy is the division of the femur at a point 1 inch above the adductor tubercle, for knock-knee or for bowing of the lower part of the femur.

Osteotomy of the tibia is performed at the centre of the curve, the bone being approached on the concave side.

After-fixation in plaster or splints in the corrected position is necessary for four weeks in the case of the tibia, for six to eight weeks in the case of the femur, according to age.

Genu Valgum, or knock-knee, is the condition in which the leg is deflected outwards at the knee. It may be due to—

1. Rickets.

2. Changes similar to those of rickets occurring at the epiphyseal lines of the knee region in adolescents, but unaccompanied by changes in other bones, or by constitutional symptoms (adolescent genu valgum), or much less commonly

3. Infantile paralysis in which the biceps is the most powerful persistent muscle.

4. Excision of the knee in childhood.

Anatomically the condition may be due to—

1. Curvature of the shafts of the femur and tibia, a usual cause in the rickety form.

2. Obliquity of the articular surfaces on the shaft, the usual cause in the adolescent form. If this is the cause the deformity disappears on flexion of the knee.

The internal condyle is very prominent, and appears unduly large. The patella may be displaced outward. Flat-foot and lateral curvature of the spine may be associated deformities. Very often, however, the feet become overarched, the child walking on the outer borders in order to bring the feet nearer together.

Treatment in the slighter cases is carried out by splints in young children, or an outside iron to the hip without joints in older. If the deformity is well established, it must be corrected by McEwen's osteotomy. In very severe cases an osteotomy of the tibia is also necessary.

Coxa Vara is the name given to that anatomical condition in which the angle made by the neck and shaft of the femur (normally about 125 degrees) is diminished.

It may arise from various causes :

1. Congenital, very rare, and usually accompanied by other deformities—*e.g.*, talipes, knock-knee, defective growth of the femur.

2. Rickets.

3. Traumatic, after fracture of the femoral neck.

4. In osteo-arthritis.
5. Adolescent.
6. Infantile.

Adolescent or Epiphyseal Coxa Vara is much more common in boys than in girls, is most often unilateral, and arises at twelve to eighteen years.

Anatomically it consists in a slipping of the epiphysis of the head of the femur downwards and backwards upon the neck. This may be caused by—

1. Direct separation of the epiphysis by violence.
2. Loosening of the epiphysis by slight violence, followed by gradual displacement some months later.
3. Displacement without violence in cases where the ossification at the epiphyseal line is imperfect. The bilateral cases belong to the last class.

The **Symptoms** in the early stages are pain in the hip and referred to the knee, and limp. On examination the limb is found to be adducted and everted, and all movement at the hip-joint may be lost. There is real shortening and wasting, and the trochanter is raised. In the later stages movement returns, but abduction and inversion are limited.

The diagnosis is made from tuberculous disease by—

1. The presence of real shortening at an early stage of the disease.
2. The skiagraph.

Treatment consists of rest and extension in the abducted position in the early stages, followed by the application of a Thomas's knee-splint, to relieve the hip-joint from all pressure, for from six months to several years. If adduction and eversion deformity are severe, they are to be corrected by an osteotomy through the trochanteric region, with removal of a wedge from the outer side if necessary.

Infantile, or **Cervical Coxa Vara,** is equally common in girls and boys, is often bilateral, and the symptoms may be noticed when the child begins to walk, or at any subsequent time up to ten or eleven.

Anatomically there is a depression of the whole neck, which in many cases is united to the trochanteric region by fibrous tissue, showing in a skiagraph as a **V**-shaped clear space. The deformity is caused by displacement of the head of the femur, occurring at a time when the neck is largely cartilaginous.

Little is known of the causation, but the displacement may be due to—

1. Fracture of the neck in infancy.
2. Softening of the bone from rickets.

The **Symptoms** are a waddling gait, resembling that of congenital dislocation with great lordosis. Movements are free except abduction. The limb is shortened and the great trochanter raised.

The deformity tends to increase, and to prevent this a Thomas's calliper splint should be worn. Adduction is corrected by trans-trochanteric osteotomy.

Deformities due to Joint Disease.

Acute Arthritis of the Hip, accompanied by suppuration, usually leads to destruction of the head of the bone and dorsal dislocation. This condition is incapable of improvement. Where no external

RADIOGRAPH OF A CASE OF ADOLESCENT COXA VARA, SHOWING DISPLACEMENT OF THE HEAD OF THE FEMUR DOWNWARDS AT THE REGION OF THE EPIPHYSEAL LINE.

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PLATE XLVIII.

Adolescent Coxa Vara, showing the Great Adduction and Consequent Apparent Shortening, also the Prominence of the Great Trochanter.

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suppuration occurs—*e.g.*, gonococcal infection—ankylosis usually occurs.

Tuberculous Arthritis of the Hip, if well and early treated, should end in either complete recovery or bony or fibrous ankylosis in a straight or slightly abducted position. The common deformities found result from ankylosis in a flexed and adducted position, with often, also, much inversion or eversion. Whilst the disease is still possibly active, no endeavour must be made to correct these by forcible means, but if there is no bony union, improvement may be secured by prolonged extension. Several years after all active disease has ceased, vicious position may be improved by—

1. Subtrochanteric or transtrochanteric osteotomy, with the removal of a wedge if necessary.
2. Forcible manipulation under an anæsthetic.
3. Excision of the head of the femur.

Osteotomy is most successful in cases of bony ankylosis; if the union is fibrous, deformity is liable to recur. Forcible manipulation is suitable only for cases of fibrous union. There is a possibility, when it is used, of lighting up fresh disease. Excision with replacement in a good position is most suitable for cases of fibrous ankylosis with much deformity. After osteotomy, fixation on splints or plaster for eight to ten weeks is necessary. After manipulation or excision, fixation for a much longer period, even up to several years, is advisable, owing to the liability to recurrent deformity; or, in the case of excision, to dislocation.

Disease of the Knee-Joint, of whatever nature, may result in—

1. Complete return to the normal.
2. Bony or fibrous ankylosis in the good (straight), or in a bad position—*e.g.*, flexion, genu valgum or varum.

When a small amount of deformity exists in an ankylosed knee, there is a tendency for it to increase as the result of the pressure of the weight of the body. This occurs even when the union is by bone.

Fibrous union in a faulty position is therefore to be treated by extension or forcible manipulation, followed by long retention in plaster of Paris, or in a Thomas's calliper splint. Vicious bony ankylosis, or resistant fibrous union in children over fourteen years of age, is to be treated by excision. If this operation is performed in younger children, there is a risk of subsequent shortening from arrest of growth and of recurrent deformity. In young children, therefore, treatment must be postponed, or an attempt made to straighten the knee by continuous pressure with a powerful anterior steel spring (Hessing's apparatus). In all cases after correction, the patient must be kept under supervision until growth is complete.

Paralytic Deformities of the Lower Limb.—Infantile Paralysis causes the loss or weakness of certain muscles or muscle groups. In some cases the contraction of the remaining muscles gives rise to a fixed deformity. The commonest of such fixed deformities are—

1. At the hip, flexion with abduction and eversion due to contraction of the sartorius and tensor fasciæ femoris.
2. At the knee, flexion with eversion and backward displacement due to contraction of the biceps.
3. In the foot the varieties of paralytic talipes.

In the **Treatment** of a paralytic deformity of the lower limb, it is first necessary to find out exactly what remnants of muscular power

remain, by testing the power of voluntary movement, and by testing the muscles electrically. The principles of treatment are then—

1. Correction of any fixed deformity by repeated movements, or forcible movements, or by tenotomy, or tendon lengthening.

2. Provision of the simplest and lightest instrument that will enable the patient to walk in a natural position.

3. Special operations, such as tendon transplantation, nerve grafting, and arthrodesis.

The instrument necessary must be judged by the power remaining in the various muscles, and by the method of progression adopted by the patient when without a support. If the limb has never been used for walking, the power of flexing and extending the hip-joint must be specially tested. Complete loss of the flexors will prevent the limb being lifted forwards, but does not contra-indicate walking. Complete loss of the extensors (glutei) may render the limb useless.

Arthrodesis is an operation designed to secure bony ankylosis of a joint in a good position. It is specially useful at the ankle and subastragaloid joints, to stiffen a flail foot. Arthrodesis of the knee may be performed for flail or flexed knee ; but this joint can be fixed quite efficiently by a double iron. Arthrodesis of the hip has not been successfully performed for paralysis.

Tendon transplantation consists in the insertion of the whole or part of the tendon of an active muscle into the lower end of the tendon of a paralyzed muscle, or to a new bony attachment. It serves two purposes : (1) To diminish or do away with the action of the strong muscle ; (2) to replace as far as possible the action of the paralyzed muscle.

Arthrodesis and tendon transplantation cannot be considered to be really successful unless they reduce the walking apparatus subsequently required, or enable it to be worn more comfortably.

Nerve-grafting—e.g., grafting a part of the internal popliteal nerve into the peroneal in a case of paralysis of the anterior tibial group of muscles, has not so far been successful.

Spastic Paralysis of the lower limb causes deformity by the persistent contraction of those muscles which are more powerful or work at a mechanical advantage. In hemiplegia or paraplegia, the position usually assumed is, at the hip flexion, adduction and inversion, at the knee flexion, in the foot talipes equino varus.

The shortened muscles may be tenotomized, but the correction obtained is often only temporary.

Deformities of the Foot.—The bones of the tarsus and metatarsus are arranged in two arches, so that the weight is borne in standing or walking on certain points, the intermediate part of the foot touching the ground very lightly or not at all. The **longitudinal arch** consists of the os calcis, astragalus, scaphoid internal cuneiform, and first metatarsal bones on the inner side, the bearing points being the heel and the head of the first metatarsal, the intermediate portion of the arch being raised completely off the ground. On the outer side the longitudinal arch is less marked. It consists of the os calcis, cuboid, and fifth metatarsal bone ; the bearing points are the heel and the head of the fifth metatarsal bone, the soft parts under the centre of the arch normally touch the ground. The **transverse arch** consists of the three cuneiforms, and the cuboid, and of the five metatarsals ; its bearing points are the heads of the first and fifth metatarsals, the

immediate bones being raised, but the soft parts in contact with the ground.

The **Longitudinal Arch** is supported by—

1. **Ligaments.**—The calcaneo-scaphoid, short and long plantar ligaments, and plantar fascia.

2. **Muscles.**—The tibialis anticus, tibialis posticus, flexor longus hallucis, flexor longus digitorum, and short muscles of the sole. On the outer side the peroneus longus and brevis assist.

The **Transverse Arch** is supported by the interosseous ligaments, by the transverse metatarsal ligaments, and by the peroneus longus muscle.

The movements of the ankle and foot are very complicated, but may be classified into four main movements :

1. **Dorsal Extension*** at the ankle-joint (30 degrees), carried out by the tibialis anticus, extensor longus hallucis, extensor longus digitorum, and peroneus tertius.

2. **Plantar Flexion*** at the ankle-joint (60 degrees), carried out by the gastrocnemius and soleus, tibialis posticus, flexor longus hallucis, flexor longus digitorum, and peronei.

3. **Varus**—*i.e.*, inversion and adduction, carried out by the tibialis anticus, tibialis posticus, and long flexors.

4. **Valgus**—*i.e.*, eversion and abduction, carried out by the peronei and long extensors.

At the ankle-joint the movements are flexion and extension ; according to some anatomists, however, a little lateral movement is also allowed in full plantar flexion.

Varus and valgus movements occur at the subastragaloid, mid-tarsal, and other tarsal and metatarsal joints. A little additional flexion and extension is permitted at the mid-tarsal joint. Plantar flexion at this joint causes an increase in the arch of the foot. Owing to the support given by strong ligaments, no decrease in the arch is possible in the normal foot.

Talipes, or club-foot, may be fixed or a postural deformity. In fixed talipes the foot is held in some position, which is normally the result of muscular action, or in some exaggeration of such position. In postural talipes some normal movement is weak or absent, so that the foot fails to retain its proper shape when the weight is borne by it.

Postural talipes is due to weakness or paralysis of some muscle or muscles. Fixed talipes is usually primarily due to overaction of certain muscles. Secondarily, however, the ligaments become shortened and the bones deformed.

The anatomical varieties of talipes are—

1. **Talipes Equinus**—*i.e.*, plantar flexion.
2. **Talipes Calcaneus**—*i.e.*, dorsal extension.
3. **Talipes Varus**—*i.e.*, inversion and adduction.
4. **Talipes Valgus**—*i.e.*, eversion and abduction.
5. **Talipes Cavus**—*i.e.*, overarching of the sole, and various combinations of these, the commonest being—
6. **Talipes equino-varus, and equino-cavo-varus.**
7. **Talipes calcaneo-valgus and calcaneo-cavo-valgus.**
8. **Talipes equino-valgus.**

* Owing to the misuse of the terms "flexion" and "extension" as applied to foot movements, it is better to affix "dorsal" and "plantar" to these terms. The terms are here used in the sense which is correct as judged by comparative anatomy.

Flat-foot, or pes planus, is not properly classed as a variety of talipes.

The causes of talipes are—

1. **Congenital.**
2. **Paralysis (lower motor neurone)** affecting the leg muscles unequally—*e.g.*, infantile paralysis and injury of nerve trunks.
3. **Paralysis (upper motor neurone)**—*i.e.*, hemiplegia or paraplegia.
4. **Cicatrization in muscles** after septic myositis or injury.
5. **Cicatrization of skin.**
6. **Defective growth** of the lower end of the tibia or fibula.
7. **Habitual posture.**

The last cause is usually instanced by talipes equinus occurring in a short leg, where the patient habitually walks on the toes, and in bedridden people, whose feet lie continuously in the equinus position (talipes decubitus). Such causation is extremely uncommon.

Congenital Talipes Equino-Varus is one of the most common congenital abnormalities. It is most often bilateral, and is not uncommonly associated with other deformities—*e.g.*, congenital dislocation of the hip, spina bifida, club-hand, etc. Occasionally there is a family incidence of the deformity extending through several generations.

Several possible causes are given. It is difficult to prove any for certain. Probably the cause varies in different cases.

1. A primary developmental defect. This is probable in family cases, and where other deformities exist.
2. Pressure *in utero* from a defect of liquor amnii. In the last months of intra-uterine life the feet of the fœtus are normally held in the equino-varus position. This cause is certainly the probable one when there are associated amniotic constrictions.
3. Paresis or paralysis, particularly of the peroneal muscles. A probable cause in cases associated with spina bifida.

Anatomically the deformity is complicated. It may be resolved into—

1. Adduction and inversion of the foot, occurring mainly at the subastragaloid and mid-tarsal joints, so that the toe points inward, and the sole looks backward and inward (varus).
2. Contraction of the tendo Achillis, so that if the varus deformity is corrected manually, the toe points down (equinus).
3. Internal rotation of the whole foot and ankle, including the lower end of the tibia. So that when both varus and equinus are corrected, the foot, although flat, still points inward.

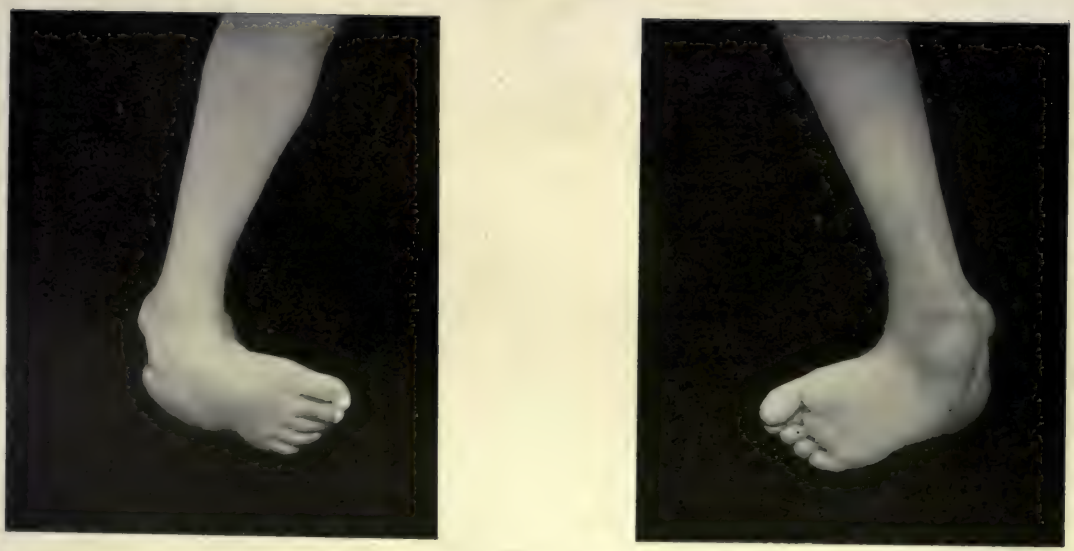
The tendo Achillis, tibialis anticus and posticus, long flexors, internal lateral ligament, and to a less extent the ligaments and muscles of the sole, are shortened. The tarsal bones or their cartilages are modified in shape, the chief variation being in the direction of the neck of the astragalus, which points much more downwards and inwards than normally. Occasionally the foot is further misshapen by the absence of the heel, and the leg may be short, or fail to grow at the proper rate.

In cases untreated until after the child has walked, the deformity becomes worse, the sole more contracted (cavus), the astragalus more deformed, and a bursal pad arises on the outer side, over the cuboid, the point upon which the weight is borne.

The **Principles of Treatment** are—

1. To correct the deformity as early in life as possible.
2. To retain the foot in the corrected position by means of suitable

PLATE XLIX.



CONGENITAL TALIPES EQUINO-VARUS.

There is a large bursa over the region of the cuboid.

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apparatus until it can be used normally for walking in an ordinary shoe or barefoot, a period of several years is required.

During the first period of life before the child has walked, treatment should be confined to manipulations and splinting, the only operations permissible being tenotomies. This method of treatment is best carried out in three stages.

1. The varus deformity is corrected by daily manipulations of the foot outwards, a malleable iron splint being bandaged to the outer side of the leg and foot between manipulations, and the splint bent as the foot becomes straighter. If improvement is not rapid, the tendon of the tibialis anticus should be divided, the varus deformity overcorrected, and the foot and leg to above the knee fixed in plaster of Paris. When the varus is corrected, the plantar fascia, if tight, should be divided.

2. When the foot remains in a straight line with the leg after the splint or plaster is removed, the equinus portion of the deformity should be corrected by division of the tendo Achillis, wrenching (if necessary), and application of plaster. A plaster case or iron shoe, such as the Thomas club-foot brace, must be retained night and day on the corrected foot, until the child begins to walk.

3. As soon as the child walks, a proper walking apparatus must be applied. In doing this the inward torsion of the foot must be corrected. If the latter is slight, an inside iron to the calf with varus T-strap applied to a boot, of which the outer half of the sole is made ½ inch thicker than the inner, will suffice. If the torsion is severe, a second iron must be carried up the outer side of the limb to the waist, and the limb everted by means of this.

The walking instrument by day and the iron shoe by night must be continued until there is no tendency to relapse—*i.e.*, for several years—and the walking instrument retained until there is no longer any tendency to inversion.

In older children and in relapsed cases persistent treatment by the same means, manipulations, and forcible correction, with tenotomy, will usually suffice, but some additional operations may be performed.

1. **Tarsectomy**—*i.e.*, the removal of some part of the outer side of the tarsus. There are several methods : (1) Removal of the astragalus ; (2) removal of a wedge from the outer side of the tarsus ; (3) removal of the cuboid ; (4) scooping out the interior of the astragalus, and crushing the remaining shell of bone.

2. **Phelps's Operation** consists in the division of the skin and all structures on the inner side of the sole down to the head of the astragalus, forcibly correcting the deformity, and leaving the wound to granulate. It is usually modified by first reflecting a triangular flap of skin, which is stretched lightly in place over the raw area.

After any of these operations there is the same tendency to relapse as in cases treated by less drastic means, and the same retentive and walking apparatus must be used.

Congenital Talipes Calcaneo-Valgus is a much less common deformity, but the slighter degrees are not infrequent.

The foot is hyperextended (dorsally), everted, and abducted.

In early cases daily manipulations inward, and the wearing of a splint on the inner side to plantar flex, adduct and invert the foot, will usually cure the deformity before the child walks.

If the deformity is still present in a child who walks, a boot with outside iron to calf, valgus T-strap and a pad under the instep if the arch is deficient, will usually suffice to cure.

Occasionally in neglected cases the peronei and the extensor muscles are contracted, and tenotomy of these, with forcible inversion of the foot and fixation in plaster, is necessary as a preliminary measure.

Other forms of congenital talipes are extremely rare.

Paralytic Talipes is much more variable in form than is the congenital variety. Talipes equinus, equino-varus, equino-valgus, valgus, and calcaneo-valgus, are all frequent.

The diagnosis from congenital deformities is made by the history of late onset, the partial or complete loss of certain muscles as tested by their use or by their electrical reactions, the diminution or loss of the deep reflexes if the muscles involved in them are paralyzed, and by trophic disturbances—*e.g.*, coldness, chilblains, and deficient growth in length of the limb.

When the deformity is fixed, treatment consists first in its correction by tenotomy of the shortened tendons, and manipulations, either persistent or forcible.

After-treatment consists in the provision of a suitable walking apparatus, which must keep the foot in walking as nearly as possible in its normal position, and enable all muscles capable of use to come into action—*e.g.*, if the anterior group of muscles of the leg are lost the posterior and peroneal groups being intact, a boot with a double iron to calf, a valgus T-strap, and a toe-raising spring, forms the correct instrument. If, however, the anterior group is weakened only, the toe-raising spring should be weakened or omitted so that these muscles may function.

Tarsectomy may be performed in cases of resistant paralytic talipes, as in the congenital cases. It is, however, very rarely required.

Tendon lengthening may replace tenotomy in order to lengthen tendons by a definite amount.

Tendon transplantation may be carried out in certain cases, the whole, or part, of the tendon of an active muscle being transplanted to a new bony attachment, or into the tendon of a paralyzed muscle—*e.g.*, the peroneus longus tendon may be transplanted into the tendo Achillis in cases of paralytic talipes calcaneo-valgus.

Arthrodesis is sometimes beneficial in flail feet—*e.g.*, arthrodesis of the ankle for flail ankle, or arthrodesis of the calcaneo-atragaloid joint for severe paralytic valgus.

Spastic Talipes.—The talipes occurring in hemiplegia and paraplegia is peculiar in that it is due to contraction of the muscles concerned without permanent shortening, and that consequently the deformity can be temporarily corrected in a few minutes by steady pressure or by anæsthesia. If the tendo Achillis and tibiales are contracted, talipes equino-varus results ; if the peronei and extensors contract, there is talipes calcaneo-valgus.

These conditions are usually treated by the application of an appropriate instrument. Occasionally tenotomy of the shortened muscles must be performed. Unless great care is taken, there is then some risk of overcorrection of the deformity.

Pes Cavus, overarching of the foot, may be part of a congenital or paralytic talipes, or may occur alone. It is not uncommon as

a primary deformity of both feet in children and adolescents. It is then usually ascribed to paresis of the interossei. It may be a family peculiarity, or may result from the wearing of short and high-heeled shoes.

On the other hand, pes cavus may be the initial symptoms of certain nervous diseases, particularly of Friedreich's ataxia and of the peroneal type of progressive muscular atrophy.

Secondarily the toes become clawed, and corns form under the heads of the metatarsal bones.

Treatment in severe cases is by tenotomy of the plantar fascia, and stretching, with subsequent fixation in plaster or in a Scarpa's shoe.

Flat-Foot and Valgus.—In flat-foot there is a partial or complete loss of the longitudinal arch. In pes valgus there is abduction and eversion of the foot at the subastragaloid and mid-tarsal joints, the

A. *B.* *C.*

FIG. 39.—FOOTPRINTS.
A, Normal; *B*, overarched; *C*, flat.

arch being intact. The two conditions are not uncommonly combined, but there may be a considerable degree of valgus without any loss of the arch, or even in a foot which is overarched.

In order to complete a diagnosis of flat-foot from that of weak foot or valgus, a print of the sole must therefore be taken. This is easily done by making the patient step first upon a pad soaked with potassium ferrocyanide solution, and then upon a piece of blotting-paper impregnated with perchloride of iron. A Prussian blue print results.

Flat-foot and valgus occur in three stages or degrees.

1. By tip-toeing or standing upon the outer border, the foot is brought into perfect position, and the arch, if depressed, is reconstructed.

2. This is impossible, but by manipulation with the hands the foot can be inverted and adducted, and brought into shape.

3. The foot is rigid, and cannot be inverted and adducted by manipulation without anæsthesia.

In valgus of the first degree there is relative weakness of the tibial muscles and of the long flexors only. In the second degree this weakness is much more extreme. In the third degree there is spasm of the opposing muscles (peronei and extensors). In flat-foot the degrees are the same, but there is, in addition, yielding of the ligaments which support the arch; and in the third degree there are often abundant adhesions in or around the joints.

The **Causes** of flat-foot and valgus are—

1. Prolonged strain from standing.
2. Weakening of the ligaments of the sole from (1) general diseases, such as rickets; (2) arthritis of the tarsal joints, such as rheumatism, osteo-arthritis, and gonorrhœal arthritis.
3. Paralysis of the tibial muscles in infantile paralysis.
4. Congenital talipes calcaneo-valgus not corrected in early life.
5. Accidents to the ankle region such as severe sprains, Pott's fracture, etc.
6. Tuberculous disease of the tarsus or ankle.
7. Rigidity of the great toe joint not permitting proper use of the arch of the foot in walking.

The first two causes are the common ones in ordinary static flat-foot. The last is frequent in adolescents.

The pain of flat-foot is felt under the instep in the slighter cases, but when rigidity is present, there is often severe pain up the outer side of the leg. In very old-standing fixed flat-foot there may be no pain, although the walk is very unsightly.

Treatment must depend on the degree of deformity, the age and work of the patient.

The first degree is to be treated by massage and exercises, such as tip-toeing and walking upon the outer border.

The second degree is treated by massage and resisted movements, and by so modifying the boot as to throw the foot on to its outer side. This is done by raising the inner border of the sole (clumping) and thickening the fore and inner part of the heel, and carrying it forward under the instep. If the arch is lost, it is held up by a pad or steel plate in the boot, or by strapping the foot.

In the third stage the first step is to get rid of the rigidity. In recent cases this can usually be done by a week's rest in bed. In more resistant cases forcible inversion of the foot under an anæsthetic, with fixation in plaster of Paris in this position for two to four weeks, is necessary. After this a boot with sole modified, as already mentioned, an outside iron to the calf, valgus T-strap, and pad in the boot, is necessary for a time.

Each stage should pass under treatment into the previous stage, and the treatment then be modified appropriately. The age of the patient, his weight, and his work, have to be considered in every case. Thus, a condition which in an adolescent could be confidently treated by rest and subsequent massage and exercises, might in an older man require the provision of an instrument. The subsidiary causes—*e.g.*, arthritis, paralysis, etc.—must also be borne in mind throughout.

Hallux Rigidus is a condition common in adolescents in which the metatarso-phalangeal joint of the great toe becomes painful and rigid, and tends subsequently to become flexed (hallux flexus). The

changes found in the joint are those of osteo-arthritis. In addition to the pain involved, the condition is important as assisting in the causation of flat-foot.

It is treated by manipulations, and tends in most cases to reach a stage when it ceases to give trouble. Intractable cases are to be treated by excision of the head of the metatarsal bone.

Hallux Valgus consists in adduction of the great toe at the metatarso-phalangeal joint. The head of the metatarsal bone projects on the inner border of the foot, and a bursa forms over it (bunion). Osteo-arthritic changes occur in the joint.

It is ascribed to the wearing of tight boots, but may certainly arise apart from this cause. A very severe degree of hallux valgus may arise rapidly in old people as the result of polyarticular rheumatoid arthritis.

Treatment in the slighter cases consists in the wearing of a boot with a straight inner border, the great toe being kept in position by a toe-post, or by a spring along the inner side. In severe cases excision of the head of the metatarsal bone is advisable.

Hammer-Toe usually affects the second toe. The metatarso-phalangeal joint is hyperextended, the first interphalangeal joint acutely flexed. Corns form on the upwardly directed angle. The condition often coexists with hallux valgus ; its cause is not known. It is usually treated by excision of the head of the first phalanx and subsequent fixation on a splint until ankylosis occurs.

Metatarsalgia is the name given to attacks of acute neuralgic pain felt in the region of the head of the fourth metatarsal bone, usually coming on suddenly during walking, and relieved by removing the boot. The condition is due to a dropping of the head of the fourth metatarsal bone, owing to weakness or rupture of the transverse metatarsal ligament. In some cases a clear history of an accident can be obtained. It is presumed that the digital nerves become nipped between the heads of the metatarsal bones.

Treatment consists in the support of the head of the fourth metatarsal by a pad in the sole-plate, or by a band of strapping encircling the fore part of the foot. If this is not successful, the head of the bone must be excised.

CHAPTER XV

INJURIES AND DISEASES OF BLOODVESSELS

Hæmophilia—Purpura—Scurvy—General signs of injury to bloodvessels—Hæmorrhage: Varieties, prevention and arrest—Bleeding from special situations—Constitutional effects of hæmorrhage—Repair of bloodvessels—Natural arrest of hæmorrhage—Injuries to arteries—Injuries to veins—Thrombosis—Phlebitis—Embolism—Arteritis—Aneurism—Varicose veins.

PREDISPOSING CAUSES OF HÆMORRHAGE

THE gravity of an injury to the vascular system will depend to some extent on its healthy condition; on the absence of such constitutional diseases as purpura and scurvy, one of the characteristics of which is a tendency to bleeding, and of the peculiar congenital condition known as " hæmophilia."

The injury may be direct and simple, such as that due to a wound with a sharp or blunt instrument, or it may be indirect and part of a larger accident, such as the wounding of a vessel in compound fracture.

The condition may be apparent, as when an accident which injures the vessel also involves the skin, when the hæmorrhage is external ; or it may be concealed, as in the involvement of a vessel in simple fracture, or the injury to a large artery or internal organ without a skin wound.

We will first consider those constitutional conditions which modify injuries to the vascular system.

Hæmophilia—sometimes called the " hæmorrhagic diathesis "—is an hereditary and congenital disorder. Da Costa states that there is an acquired form. The cause of the condition is unknown. Both the vessels and the blood appear to be normal, though the latter shows the changes found in secondary anæmia, and is slow in coagulating. The mode of transmission is peculiar. As a rule it descends through the females to the males. Thus a mother will transmit the condition to a son, while she herself is not subject to it. Females seldom suffer from the condition.

An injury, though trivial in itself, to a person suffering from this disease may lead to a fatal issue, on account of the bleeding, and even if this be stopped, to profound anæmia, from which the patient may not recover.

It will at once be seen that, should a patient who is the subject of hæmophilia meet with an injury, however trivial, the results may be serious or fatal. Even should the skin not be broken, internal hæmorrhage may lead to collapse or to disorganization of some important structure—for example, a slight injury to a joint, such

as a sprain or strain, often leads to a large effusion of blood into the articular cavity. Here, owing to the circumscribed area of the cavity and its hard walls, there is not any danger to life so long as no attempt is made to aspirate the cavity, but total destruction of the joint may take place; at times there is complete recovery. Should a large internal organ be severely injured, death will probably ensue, since there is nothing to limit the bleeding.

The **Prognosis** of such a condition is, of course, bad. Should the patient recover, he is still always liable to a recurrence of the hæmorrhage on the slightest injury, from which, but for his hereditary predisposition, he would not have suffered any inconvenience.

The **Diagnosis** is, unfortunately, all too plain, in consequence of the persistent and inexplicable bleeding. The only condition which may give rise to uncertainty is hæmorrhage into a joint cavity, and even here the rapidity with which it becomes distended should, as a rule, lead to a correct diagnosis.

Purpura Hæmorrhagica.—This is most commonly met with in young and delicate persons, especially females, though not alone in them.

There is usually a crop of purpuric spots on the skin. Bleeding from the mucous membrane is a constant symptom ; epistaxis, hæmaturia, and hæmoptysis causing profound anæmia, may occur. There is, as a rule, little feeling of sickness with this disease, and a person may continue at his employment : consequently, if an injury occur to a patient suffering from purpura hæmorrhagica, he may present symptoms of hæmorrhage which are inexplicable if we do not bear in mind the possibility of its presence.

Diagnosis.—This is made chiefly by the presence of the spots and the circumstances of the occurrence of bleeding. Scurvy should be excluded by consideration of the previous health and the absence of swollen gums.

Scurvy.—One of the symptoms of this disease is the tendency to hæmorrhage. The gums are spongy, and bleed very easily ; but the important feature to remember is that the slightest injury causes bleeding, and if the man's diseased condition is not recognized, it may be thought that the injury is the sole cause for the condition of weakness present. Bleeding may also occur from the mucous membranes.

Diagnosis.—This is not very easy in isolated cases, and usually has to be made from the personal history of the individual.

General Signs of Injury to Bloodvessels.

The following may be taken to be the general signs of injury to bloodvessels : Interruption of the circulation, and local hæmorrhage, seen or unseen. These may appear at once, or not till a later period. In feeling for pulsation beyond an injured artery, the opposite side of the body should be compared, as frequently variety of pulsation is present without being due to injury.

Local pallor and numbness are usually present, and in the case of an injured vein, congestion. A swelling more or less marked and having considerable tenseness is present when a large vessel has been ruptured. If there be loss of pulsation without much local swelling, a contusion of the vessel is indicated, and thrombosis has occurred ; if there be local swelling, then a ruptured vessel may be diagnosed.

In a case of fracture or dislocation, compression of the artery may cause temporary cessation of pulsation, which returns when the displacement has been remedied, provided that such compression has not existed sufficiently long to set up thrombosis from injury of the vessel walls.

A considerable swelling with a normal pulse beyond indicates a ruptured vein. If a firm cord be felt after an injury, and there is no loss of pulsation, local thrombosis of an injured vein is indicated.

HÆMORRHAGE.

Hæmorrhage is the immediate result to be feared in an injury to a bloodvessel.

Arterial hæmorrhage is characterized by its bright red colour, by its occurring in jets synchronous with the heart-beats, and by the blood usually coming from the proximal end of the vessel, though, if the collateral circulation is abundant at the part injured, blood may also come from the distal end.

In venous hæmorrhage the blood flows from the distal end and is dark in colour.

Capillary hæmorrhage is shown by a general oozing of blood, which is bright red or dark according to the proximity of the injury to the arteries or veins of the part, but it is always somewhat darker than that derived from arteries.

If the hæmorrhage be severe, as in injury to an important vessel, death results from syncope. The surface of the body rapidly becomes cold, the face livid, while the patient gasps for breath. If the bleeding is not so severe, collapse occurs, and on recovery there is more or less anæmia, which in a healthy subject rapidly disappears.

In venous hæmorrhage there are several remote dangers. An embolus may be formed from the breaking away of part of the reparative thrombus, or pyæmia may be set up by septic infection of the thrombus at the cut end of the vessel.

The surgical cure of hæmorrhage is to imitate more or less Nature's methods by artificial means.

If an artery be completely severed, retraction of the vessel within its sheath occurs. At the same time the vessel contracts, an external coagulum forms on the roughened inner surface of the sheath, and an internal one is also formed, usually extending as far as the nearest collateral branch. This coagulum is gradually organized, and permanently seals the divided artery.

In veins and capillaries the walls fall together, and a coagulum, chiefly external, is formed, subsequent stages being similar to those in the arteries.

A danger to be remembered is that from a partially divided artery, even of small calibre, bleeding will be continuous till the artery is completely severed.

In examining an injury, the likelihood of a particular organ or vessel being wounded should be taken into account. Thus, with regard to an injury possibly involving a bloodvessel, the position is of importance, and the question should be asked, "Is an important vessel likely to have been implicated owing to the position of the wound or other injury?"

VARIETIES OF HÆMORRHAGE.

Primary Hæmorrhage is that which follows immediately on an injury to a bloodvessel, whether by accident or in a surgical operation.

Reactionary Hæmorrhage occurs within a few hours of the injury or operation, and is due to the increased blood-pressure which results from the vitality of reaction displacing clots which have formed, or producing bleeding from vessels which did not bleed at the time of injury or operation. The same cause may also produce bleeding by the giving way of a ligature, or of a badly damaged portion of a bloodvessel.

Secondary Hæmorrhage is due to interference with the natural repair of a damaged vessel from some cause, and does not usually occur till some time after an injury or operation. It is generally due to a septic process, and the term may be held to include the erosion of a bloodvessel by an abscess or the destruction of its walls in a septic wound. The infection may reach the vessel wall from without by a suppurating wound or infective ligature material, or from within by the blood-stream, and causes softening and degeneration of the vessel wall and of the blood-clot. When the secondary hæmorrhage is from a small vessel, purification of the wound and plugging with antiseptic gauze may suffice, and is the only means at our disposal in bleeding in the neck, groin, or pelvis. When the bleeding is from a large vessel in a limb, ligature of the main artery higher up will probably be necessary.

PREVENTION OF HÆMORRHAGE.

Previous to an operation, the limb should be held vertical for a minute or so. While in this position an elastic bandage should be applied from below up. Esmarch's elastic tube is passed firmly round the limb at the level of the last turns of the bandage, and fastened. The bandage is then removed.

Petit's screw tourniquet is now seldom used, but it may be useful to avert secondary hæmorrhage.

When it is not convenient to apply a tourniquet, hæmorrhage may be prevented by tying or clamping the main artery above the site of operation.

Digital compression of the main vessel of the part may also be employed. It is usually made where the vessel lies in close relationship to a bone.

Thus, the common carotid artery is pressed backwards and inwards against the transverse process of the sixth cervical vertebra.

The temporal against the zygoma anterior to the ear.

The facial against the lower jaw where the artery crosses the bone.

The subclavian against the first rib by pressure down and back, applied in the hollow above the clavicle.

The axillary against the humerus.

The brachial against the humerus or elbow-joint.

The ulnar and radial against their respective bones at the wrist.

The abdominal aorta may be compressed by pressure exerted backwards against the vertebræ by means of the closed fist or some special apparatus.

The femoral by pressure backwards and upwards against the brim of the pelvis, or outwards and backwards, with the limb everted and rotated outwards, against the femur.

The popliteal forwards against the knee-joint or lower end of the femur.

The anterior tibial by pressure backwards on the tarsus.

The posterior tibial by pressure outwards beneath the internal malleolus against the tarsus.

Arrest of Hæmorrhage.

1. **By Ligature.**—This is the usual method of securing large vessels. The severed artery having been caught by artery forceps, a ligature of catgut or silk is passed round the proximal end. It is unnecessary as a rule to tie the distal end. When the artery is only partially divided, it should be completely severed in order that its walls may contract and retract, which of itself is sufficient to stop bleeding from small arteries.

2. **By Torsion.**—By twisting the end of the vessel with forceps so as to tear the inner or middle coats, and twist the outer fibrous one, bleeding may be stopped in small vessels.

3. **By Forcipressure.**—Bleeding from very small arteries may be arrested by simply leaving on a pair of artery forceps for a few minutes.

4. **By Cautery.**—The actual or Pacquelin's thermo-cautery used to be employed for the arrest of bleeding, but is now only used where no other means can be employed, or to prevent hæmorrhage, as in the removal of piles, or to arrest it.

5. **By Hot Water.**—Capillary bleeding may be stopped by water of a temperature of 110° F., which causes contraction of the muscular fibres of the vessels.

6. **By Styptics.**—This method is useful in bleeding from the nose or the socket of a tooth. Clots being removed, one of the group of styptics, as tannic acid, alum, chloride of zinc, or perchloride of iron, is applied to the bleeding surface. The suprarenal gland extract (adrenalin) will be found to be useful in more extensive hæmorrhages which are inaccessible to other means of control, such as insistent bleeding from a wound in the tongue or from the stump of an amputated tonsil. "Styptics . . . arrest bleeding by their local astringent action, either by causing coagulation of the blood, or by acting on the muscular tissue of small vessels" (Whitla).

To arrest bleeding from a **vein,** it is usually sufficient to apply pressure locally and raise the limb.

First Aid in Hæmorrhage.—The flow of blood from a vessel can be at once checked by the pressure of a finger on the bleeding-point. When this has been done, a tourniquet may be improvised by tying a handkerchief, in the fold of which a cork or piece of wood is placed to act as a pressure pad, round the limb. This pad is placed over the main artery of the limb, and a piece of wood is put between the knotted ends of the handkerchief and wound so as to exert pressure. This method is in some cases sufficient to stop the bleeding permanently, but is not to be trusted to, as secondary hæmorrhage may occur, and it is well to remember that "in order to stop hæmorrhage permanently the first step should be to **see** the bleeding-point" (Rutherford Morison).

BLEEDING FROM SPECIAL SITUATIONS.

Scalp.—Arrest of bleeding by natural means is difficult in this situation, as retraction and contraction of the vessels is prevented, owing to the density of the tissues. It is, also, often difficult to apply a ligature. A stitch may be inserted a little way from the bleeding end, or circular stitches may be used, so as to enclose the tissues of the part, and, when drawn tight, to exert pressure. This plan may also be adopted when the tissues are friable.

The Palmar and Plantar Arches.—Hæmorrhage in this situation is difficult to control locally, but may be effected by a graduated compress, which consists of a number of pads superimposed upon one another, beginning with the smallest size, and held in position by narrow bandages firmly applied. If this method fail, a tourniquet may be applied to the brachial artery, or a pad placed in the hollow of the elbow, and the forearm bandaged to the arm, with the palm of the hand looking forwards.

Tonsils.—Bleeding is, as a rule, not severe after removal of the tonsils, but if persistent it may be checked by firm pressure with gauze moistened with adrenalin solution applied by means of a sponge-holder, the patient remaining in a sitting position. Watson-Williams has introduced a pair of pressure forceps, one limb of which is applied outside and the other inside; by this means direct firm pressure can be applied to the site of bleeding. If a small artery be severed and remain unnoticed, it may give rise to severe symptoms of internal hæmorrhage, accompanied, perhaps, with hæmatemesis and bleeding from the bowel. The bleeding may be stopped by the cautery. If it is not, it will probably be necessary to cut down and ligature the main artery.

Bleeding from the Nose may be so serious as to demand active treatment. It is seldom possible to see and secure the bleeding vessel, and it becomes necessary to pack the anterior nares. This may be done by pressing a square of sterile gauze moistened with adrenalin up the nostril, and as far back as may be necessary, and packing the pocket thus formed with strips of gauze, pressing them backwards along the floor, and inwards and backwards towards the floor of the orbit, and finally directing the pressure upwards (Rutherford Morison). This usually suffices to check the bleeding, but, if not, the old method is adopted of packing the posterior nares by means of a Belloc's sound passed through the nose, and the stylet pushed along the palate to the lips. The eye is threaded and drawn back. To the middle of the thread is fastened a pledget of gauze moistened with adrenalin. This is pulled into position at the posterior nares, where it is left for twelve hours. When the bleeding is recurrent, the bleeding-points may be touched with the electric cautery.

Internal Hæmorrhage.—This may be evidenced by the passage of blood from mouth, bowel, bladder, or uterus, but may, on the other hand, not be so evidenced, and other signs have to be looked for. They are extreme pallor, quick and feeble pulse, anxious facies, restlessness, cold and clammy perspiration.

Such a condition, with increasing symptoms, will call for operation sooner or later to discover and check the source of bleeding. It must, however, be remembered that very serious bleeding, as from a gastric

ulcer, will cease spontaneously—for the time, at any rate—in most cases. It will, however, probably be recurrent, such recurrence being a good indication of the need for operation.

CONSTITUTIONAL EFFECTS OF HÆMORRHAGE.

If the loss of blood be rapid, the gravity of the constitutional symptom will be more severe than when the same quantity of blood is lost slowly. This is true of bleeding from an open wound, or internal bleeding into a serous cavity.

The temperature is usually lowered, the pulse feeble, the respiration laboured, the skin clammy, the patient is restless and thirsty, and has a sensation of giddiness. Leucocytosis is also present. Children are bad subjects for hæmorrhage, but, on the other hand, they quickly recover from its effects ; while old people are equally bad subjects, and the effects are more prolonged.

Treatment.—Is mainly that for shock. The patient should be placed in a warm bed, the foot of which is raised. The limbs may be bandaged towards the trunk. If the patient can swallow, hot milk is given by the mouth, while small doses of strychnine may be given hypodermically, but over-stimulation is to be avoided. Oxygen inhalation is useful to relieve breathlessness. The sheet-anchor for reinforcing the depleted blood-stream is the injection of 2 or 3 pints of normal saline solution, one teaspoonful of salt being used to a pint of warm water. This may be injected into the bowel, the cellular tissue, or into a vein, the median basilic being the most convenient. Unless when introduced into the rectum, the solution should be sterilized and cooled again to a temperature of 105° F. Adrenalin solution (1 in 1,000) may be added with advantage to the saline in order to raise the blood-pressure. Five minims to the pint will be found sufficient as a rule.

REPAIR OF BLOODVESSELS AND NATURAL ARREST OF HÆMORRHAGE.

If an artery be punctured, repair may be effected by means of a clot filling up the aperture and becoming organized. It is, however, liable to break down. Such an accident is one of the causes of aneurism.

When an artery is partially divided, natural cure is prevented by the walls being kept on the stretch, and therefore being unable to contract or retract until they are completely divided. When an artery is completely divided, it contracts by means of the circular fibres of its muscular coat, and retracts by reason of the elastic fibres of its coats. The internal coat curls up within the vessel, while the tunica adventitia falls over the cut ends. The blood, still escaping from the injured vessel, fills up the spaces of these tissues, and, becoming organized, forms a clot which temporarily stops the bleeding. The part of this clot which lies between the divided ends of the vessel and in the tissue outside it is called the **external clot,** while that which projects into the vessel, and usually extends to the nearest collateral branch, is called the **internal clot.** This process is known as the **temporary arrest** of hæmorrhage. The **permanent arrest** is brought about by the organisation of the clots. The internal part becomes invaded

by leucocytes and connective-tissue cells, the endothelium proliferates, and new bloodvessels penetrate the mass, forming granulation tissue, which gradually becomes transformed into cicatricial fibrous tissue, and occludes the end of the vessel. By the same process the external clot becomes converted into cicatricial tissue. The collateral branches above and below the level of the division of the artery become gradually enlarged, and the collateral circulation becomes fully established, even when large vessels have been tied or obliterated.

The repair of veins follows the same lines as that of arteries, but is somewhat modified by the difference in the structure of their coats, which allows of the thrombosed area becoming canalized, so that circulation through the vessel may be re-established.

The natural arrest of hæmorrhage may be interfered with by anything which prevents retraction or contraction of the walls, as (1) the partial division of the vessel ; (2) gaping of the vessel, owing to the nature of the tissue in which it is placed, as in the scalp, bone, or penis ; and (3) in inflamed or œdematous tissue.

When a ligature is applied to an artery imitation of Nature's method is aimed at, the internal and middle coats being ruptured, while the external one is approximated. The ligature material and that part of the vessel which is beyond it are ultimately absorbed. When, however, a vessel for any purpose is ligatured in its continuity, the coats are not ruptured, the ligature only contracting the artery so as to occlude the lumen, which leads to coagulation of the blood.

INJURIES TO BLOODVESSELS

INJURIES TO ARTERIES.

Contusions.—Contusion of an artery is not usually a matter of grave import so long as the walls are healthy, but should they be the seat of atheroma, or calcification be present, the results may be serious, as thrombosis may follow the injury, and gangrene possibly supervene. Thus we may have a workman claiming heavy compensation for a trivial injury that in a healthy subject would produce no appreciable effect, but which in the subjects of syphilis or alcoholism may lead to the loss of a limb. There are those, however, so far as our present knowledge goes, who may be the subject of arterial degeneration, and yet be free from coexistent disease.

Laceration.—This may follow a severe blow or strain. A diseased or weakened arterial wall is a strong predisposing cause that should be remembered, as it will influence prognosis adversely. The general condition of the patient's vascular system, as also his history, will lead us to a correct diagnosis on this point.

Laceration may result from surgical procedure, as in reducing an old dislocation or breaking down adhesions.

The usual condition produced is rupture of the internal and middle coats which, by forming an obstruction to the flow of blood, may, lead to thrombosis and obliteration of the vessel. If the tear be unilateral, an aneurism may be a late result on the weakened side of the artery. This is a point to be remembered in giving a prognosis, as the diagnosis of unilateral laceration is a matter of difficulty.

Rupture.—If the violence which produces the rupture be sufficient to pull away the surrounding tissues and leave the injured vessel isolated, the hæmorrhage may not be severe, as the inner coats of the vessel curl up inside, the outer contracts, and thus check the bleeding. If, however, the vessel be ruptured subcutaneously, diffuse hæmorrhage occurs to which the name " aneurism " is sometimes given. This nomenclature is misleading, since there is no true sac.

The **Signs** of such an injury are the formation of a rapidly increasing swelling, with a pulsation which synchronizes with the heart-beat. There is loss of pulsation in the vessels beyond the injury, while the limb becomes blanched at first, and later congested owing to the extravasated blood pressing on the veins. Associated with these signs there are general symptoms of collapse and shock. If the bleeding be entirely concealed, the shock may be the first symptom noticed of anything being seriously wrong with the circulatory system.

Prognosis.—This will entirely depend on the promptness and efficiency of treatment. If these conditions are met, the injury, so far as the vessel is concerned, will not be more serious than the severing of an artery in an open wound. Long delay in treatment will lead to several dangers. (*a*) The swelling may rupture, when death will result from hæmorrhage. (*b*) Suppuration may occur, owing to infection through a small wound or scratch; this will lead to sloughing of the part and external hæmorrhage. (*c*) The bleeding may continue internally, and lead to death from shock. (*d*) Pressure on veins may lead to gangrene of the limb, even if treatment be adopted after some delay; it is more liable to take place in those whose vascular system is diseased. (*e*) Gangrene may also be a late result, as the local hæmorrhage may become to a great extent checked by coagulation around the divided ends of the vessel, but pressure still continues on the surrounding vessels till degeneration or blocking supervene.

Occasionally a natural cure is effected by collateral circulation and absorption of the blood-clot.

The point to be remembered is that if treatment has been delayed, pathological results may have set in which lead to bad after-effects.

Penetrating Wounds.—The danger of penetrating wounds largely depends on whether an artery or an internal organ has been injured, and the danger of a wound to an artery depends on the size, sharpness, and cleanness of the penetrating body. A clean sharp needle may pierce the walls of a vessel through and through without doing the least harm, as the wound is immediately closed ; but should the weapon be of larger size, should it be blunt or septic, then hæmorrhage will result or endarteritis be set up. If an artery of small size be completely divided, the bleeding will quickly stop by natural cure ; if the vessel be of larger size, surgical aid will have to be rendered before the hæmorrhage is checked. A wound of a buttonhole nature, even in a small artery, will cause continuous bleeding if untreated, since the vessel cannot contract.

If a vein lies in close proximity to an artery, both may be wounded by a penetrating wound. From this one of two conditions may arise —an **aneurismal varix** or a **varicose aneurism.** The former is a direct opening from artery to vein, producing a dilated condition of the vein walls. The latter differs in that a sac composed of organized clot and cicatricial tissue is formed between the vessels.

Prognosis.—A penetrating wound of an artery may be a matter of

little moment. On the other hand, it may result in serious hæmorrhage, which leads to conditions spoken of in connection with rupture, or, if a vein is involved, may cause subsequent trouble, and require operative treatment before a cure is effected.

Inflammation of Arteries.—Accidental injury frequently produces an inflammation of arteries either externally (periarteritis) or internally (endarteritis). It is produced by serious bruising and laceration, or by wounds of the artery. An injury not involving an artery primarily may result in inflammation of its coats by a spreading septic condition of the surrounding parts.

The results of inflammation depend on two things—the previous healthy condition of the vessel walls, and whether the wound is septic or not.

In a simple bruise of an artery, even if the violence has been great, the inflammation will proceed normally, resulting probably in occlusion of the vessel—**thrombosis,** which will be referred to more particularly under Veins. If, however, the walls are degenerate through syphilis, alcoholism, etc., such a favourable termination need not be expected, even if the degenerative process involved in these diseases has not set in, the injury may prove the determining agent to start it.

In septic wounds the inflammation spreads inwards from the surrounding ulceration to the external walls, causing periarteritis; the vasa vasorum become dilated, and exudation of leucocytes takes place; toxins are produced, and lead to the softening of the vessel walls. Thus resisting-power becomes so lowered that at length, unless thrombosis has previously closed the vessel, the walls give way and hæmorrhage occurs.

The various forms of chronic inflammation of arteries are due to disease rather than injury, though in those predisposed to such diseases, as tuberculosis, syphilis, and alcoholism, it is probable, as already pointed out, that an injury, by lowering the vitality of the vessel walls, may be responsible for helping to start the diseased condition.

Prognosis.—This is good, unless disease of the vessels is present or the wound is septic, when grave results may follow, leading to aneurism, obliteration of the vessel, spontaneous rupture, general lowered vitality of the limb, and formation of emboli.

Aneurism.—This is due to a number of causes, of which injury is often one, but disease of arteries may predispose to the formation of an aneurism after injury, when otherwise it would not have occurred. Frequently a traumatic aneurism produced at the time of the accident has no true sac, it being formed by the surrounding tissues.

"Aneurism is always a serious matter in a man who has to earn his living by muscular labour, and one suffering from it is amongst that group who should be separately dealt with for insurance purposes. Not only may injury lead to the formation of an aneurism, but it may lead to the death of a patient suffering therefrom. The question may sometimes be raised on the death without injury of a man who is suffering from aneurism, 'Was death due to his employment? Might he not have died suddenly when not working?' He might have done so, and it remains for the Courts to give a precedent on the question, though the general trend of legal decisions up to the present has been to give the workman the benefit of the doubt" (Author's "Accidental Injuries to Workmen").

From the surgical standpoint there is no question but that a man who is the subject of advanced aneurism may die at any moment, with or without violence having been met with. On the other hand, anything which greatly increases the blood-pressure is of the utmost danger to such a patient.

Treatment of Arterial Injuries.—After a severe contusion, or when a rupture is incomplete, the limb should be disinfected, wrapped in cotton-wool, and placed in such a position that the venous return will be helped. If, in spite of this expectant treatment, pulsation does not return or a good collateral circulation become established, gangrene may supervene and call for amputation.

When the rupture is complete, expectant treatment may be carried out for a time; but if nutrition be seriously interfered with, or the extravasation is great and threatens the integrity of the skin, the vessel should be exposed and ligatures applied above and below the rupture.

When arteries are lacerated through an open wound, they must be ligatured, and the wound rendered aseptic. When injured through a punctured wound, it must be enlarged and the injured artery dealt with either by suture or ligature.

INJURIES TO VEINS.

Veins are subject to much the same accidents as arteries, but the results are somewhat different, owing to the constitution of their walls and the low pressure of the blood circulating in them. Thus, thrombosis as a result of injury is much more common in veins than it is in arteries.

Subcutaneous Rupture.—This occurs frequently associated with fractures and with the reduction of dislocations. The most commonly ruptured veins are the femoral and popliteal, the subclavian and axillary. Natural cure is less easy in veins than in arteries, but the bleeding is much slower, and therefore it usually ceases owing to the gradually increased pressure of the extravasated blood. A ruptured vein does not, as a rule, interfere with the pulsation in the limb, which helps to distinguish the condition from that of a ruptured artery.

Wounds.—These may be accidental, suicidal, or surgical. In the latter, especially in operations involving the neck, axilla, or groin, where the tissues are matted together, as in the removal of glands, the hæmorrhage is usually profuse, but comparatively easily combated.

Air Embolism.—By this is understood the entrance of air into a divided vein. When of large size, and situated in the thorax, neck, or axilla, a cut vein may not collapse, owing to the rigidity of its walls or its position in dense fascia, which makes them gape. The negative pressure exerted during inspiration sucks air into the right side of the heart, which is evidenced by a gurgling sound and the escape of frothy blood during expiration. The patient becomes very pale, with dilated pupils, laboured breathing, and feeble, diminishing pulse. Death may speedily result, or recovery take place gradually. To avoid this regrettable accident, great care should be exercised when operating in these regions to avoid injuring the veins, and if it is thought it will probably, or intentionally, occur, the vein should be secured by forceps

or have a ligature pressed underneath, which can be rapidly tied should the vessel be cut or punctured.

Thrombosis.—If the walls of a vein are injured so as to cause a change in the lining endothelium of the vessel, coagulation of the fluid blood contained in the vein is produced. The resulting thrombus will vary in character according to the rapidity of its formation. If quickly formed, as when a vein is divided or tied, the clot is red, owing to the inclusion of a large number of red corpuscles, and is proportionately pale according to the time taken, till in the white thrombus we have the clot formed very slowly and progressively.

The effects of thrombosis are diverse. Thus the vessel may become obliterated locally or the lumen may be re-established by shrinkage of the clot or by dilatation of the vessel. The clot may become disintegrated and washed away in the circulation, producing, if septic, localised abscesses, diffuse suppuration, or general pyæmia. Œdema of the limb, leading perhaps to gangrene, may result from obstructed circulation if a large vessel be affected. If the thrombosis be in a small vessel, the process may extend proximally till it penetrates a larger vessel, when the projecting portion of the clot may be washed away as an embolus, which, if very small, will be disposed of by the lungs or kidney; if larger, it becomes lodged in the pulmonary vessels, causing violent dyspnœa, and even death from obstruction leading to arrest of the circulation. These various possibilities must be remembered in carrying out treatment and in giving a prognosis in a case of accidental injury to veins, since death caused by an embolus is often an indirect result of the accident.

Phlebitis.—Arising from injury, may be of two types, simple and infective.

Simple Phlebitis may be due to injury, direct or indirect, open or subcutaneous. Direct injury is caused to a vein by a blow or crush, or by a sudden twist or strain; indirect by pressure of a tumour, etc. Thrombosis sets in, which usually extends up and down the vessel as far as the nearest patent branches.

Infective Phlebitis is dangerous from the fact that the thrombus is the seat of micro-organisms, usually admitted at the time of the accident. The disease is often of a spreading type, and any emboli washed away are infective. There are thus grave dangers locally and distally.

Symptoms.—The vessel becomes swollen, painful, and hard, almost cord-like; the skin is congested, and œdema is often present. In deeper veins there is great pain over the line of the vessel, and well-marked fever. Œdema is much more marked than when the superficial veins are affected.

Septic conditions are marked by smart fever, perhaps rigors, and there are signs of rapid extension of suppuration along the vein and its tributaries.

Treatment of Injuries of Veins.—When a vein is ruptured, pressure is usually sufficient to stop the bleeding, and it is not often necessary to cut down and tie the ends of the vessel unless there is evidence that a large trunk is injured, when it is wiser to do so.

When a vein is wounded by a puncture, it may be repaired by a lateral suture, or the bleeding may be arrested by means of a pad of gauze, and pressure. When any of the larger trunks are the seat of more extensive wounds, they should be ligatured or, when possible, the wound sutured.

In air embolism little can be done but to await results, meantime stimulating the heart by strychnine or the application of mustard to the chest wall. The head should be kept low to avoid syncope.

When phlebitis and thrombosis result from an injury, the patient should be placed at rest and the limb immobilized. The pain is relieved by the application of belladonna and glycerine or ichthyol. If severe, hot fomentations. with lead and opium lotions, may be required. The limb is then covered with thick layers of cotton-wool, and moved as little as possible.

DISEASES OF ARTERIES AND VEINS

THROMBOSIS AND PHLEBITIS.

Thrombosis.—This is really a symptom rather than a disease. It is the formation of a clot of blood, called a **thrombus,** in the heart or blood-vessels. The process by which the clot is formed is termed "thrombosis." It is much more common in veins than in arteries, since the blood-stream is slower and the endothelium more easily irritated in the former. The immediate causes of the condition are retardation of the blood-stream and injury of the lining membrane of the vessel, and this may be brought about by direct trauma, which has already been referred to, or by certain constitutional conditions, as gout and rheumatism; or in veins by inflammation of the vessel coats, producing—

Phlebitis.—This may be—

1. **Simple,** arising in the lower extremities of the debilitated during long confinement in bed, as in the treatment of fractures, or during post-operative confinement, especially that following prostatectomy, herniotomy, or appendicectomy.

The onset of the attack is indicated by sudden pain of a severe nature, often accompanied by a rigor and rise of temperature of several degrees. There is a feeling of stiffness of the limb. On examination, the course of the vein is marked by swelling, tenderness, and discoloration, dull red or purple, while the vessel may be felt as a knotted cord, the irregularities marking the position of the valves. There is also frequently swelling of the leg and foot. After the acute symptoms pass off, usually in the course of a few days, the swelling and tenderness last for several weeks.

In puerperal women there occurs a phlebitis of the deep veins of the lower limb, evidenced by a great swelling of the whole limb, which is of very firm consistence and of a marked white colour—**phlegmasia alba dolens,** or **white leg.**

2. **Infective.**—This usually comes from without by means of infection from the neighbouring tissue, and so begins as a periphlebitis. Suppuration sets in and destroys the vessel walls, while the thrombus which has previously formed within them becomes infected with pyogenic organisms, which reach it by the blood-stream, or direct. Portions of this softened thrombus may become detached, and lodge as septic emboli in some distant part of the circulation, and give rise to pyæmic abscesses. Infective phlebitis is met with in the lateral sinus as a sequela of chronic suppurative mastoid disease. When

occurring in other situations, as in the veins of the limbs, it is usually part of a general septic process.

The onset of the condition is marked by a sudden rise of temperature, with pain, swelling, and redness along the course of the vein. There is also a rapid œdema of the limb, and at times a localized abscess, which forms in the vein.

A **Phlebolith** is a small thrombus which undergoes calcification. It is usually situated behind a valve in a varicose vein or in the terminal end of a dilated vein.

Treatment of Phlebitis and Thrombosis.—In the simple variety the same treatment is adopted as that mentioned elsewhere for traumatic thrombosis—*i.e.*, rest, elevation of the feet, and warmth, together with the application of a sedative to relieve the pain. When septic in origin, the treatment should be energetic and directed towards the septic condition which has originated the phlebitis. In the case of a limb, it may be necessary to amputate. When the lateral sinus is affected, ligature of the internal jugular vein is carried out to prevent embolism. In both the simple and septic varieties, late treatment, **when the danger of embolism is past**—which will not be for some weeks—consists in gentle massage to get rid of the œdema. When the patient gets up, he should wear an elastic bandage for some time.

EMBOLISM.

By this is meant the carrying of an **embolus** through the arteries, where it eventually becomes impacted. The common form of embolus is a portion of a thrombus which has become detached and is carried along till it reaches a position where it becomes impacted. It may also be a vegetation from the valves of the heart, an atheromatous plate from an artery, or a small piece of a malignant tumour, which may set up a secondary growth where it lodges. When the embolus is septic, a secondary abscess is caused, as in pyæmia. Air and fat emboli have been already referred to.

The effects of embolism are very varied, according to the place where impaction occurs, and the types of the embolus—

A **simple** embolus may occasion gangrene of a limb when blocking the main vessel; sudden death when lodging in the pulmonary artery; softening of the brain and hemiplegia when blocking the middle cerebral artery, permanent blindness in the retina, dyspnœa, hæmoptysis, and sudden pain in the lungs; hæmaturia and sudden pain in the kidney; tympanites, obstruction, and gangrene in the intestines.

An **infective** embolus will occasion the above symptoms plus the formation of multiple abscesses, unless death is sudden. In the liver the embolus is usually an infective one coming from the portal area, as in appendicitis. When the infective embolism lodges in an artery, it may cause an aneurism.

A **malignant** embolus will cause metastatic growth where it lodges.

A **fat** embolus, secondary to bone injuries, usually affects the small vessels of the brain and lung.

An **air** embolus produces a frothy condition of the blood which interferes with the heart's action to a dangerous and even fatal extent.

A **parasitic** embolus is sometimes met with, and contains ova and scolices of tænia, filaria, etc., which it carries to the place of impaction.

INFLAMMATION OF ARTERIES (ARTERITIS).

This may be acute or chronic. The acute is usually traumatic in origin, and has already been dealt with.

The chronic form is very often met with in syphilis, less frequently in tuberculosis. There is marked thickening of the tunica interna, leading to narrowing or obliteration of the lumen of the vessel—**endarteritis obliterans.** The tunica adventitia is also thickened, but the middle coat frequently remains normal.

There are various conditions of the arteries which are due to syphilis; atheroma attacking the larger vessels, chronic syphilitic endarteritis attacking the small arteries of brain and kidney, endarteritis obliterans attacking many of the main arteries, aneurism following on atheroma. An injury or accident is frequently stated to be the cause of aneurism, and while it may be the determining agent in a syphilitic subject, the result would not have been the same had the injury happened to a person with healthy vessels. Gangrene of a limb may be the result of an injury for which compensation is claimed, but may in reality be due to endarteritis obliterans, and the injury have little or nothing to do with the result. Syphilitic endarteritis is often the cause of syphilitic apoplexy, giving rise to symptoms somewhat resembling ordinary apoplexy, **but of a much more gradual nature.**

ATHEROMA.

By this is understood those changes which occur in the deep layers of the internal coats of arteries leading to increased development of young connective tissue. This tissue undergoes fatty degeneration, to be followed by calcification. Later on there is a deposit of lime salts and the formation of rings or plates of calcareous material, which cover a considerable portion of the walls of the vessel. The lining endothelium may disappear, leaving the calcareous material in contact with the blood-stream, and thus frequently producing thrombosis.

These changes may also occur in the middle coats.

The **Cause** of the condition is not definitely known, and the assumption that it is a senile decay alone is too great, especially when, as some authorities state, the change is said to begin from thirty years of age onwards. A good deal depends, in the first place, on the original tissue put into the vessels—in other words, on heredity; and, in the second, on the presence or absence of the constitutional diseases of alcoholism and syphilis. Granting an absence of these causative factors, together with diseases often associated with them, in which the blood-pressure is constantly raised, as kidney disease and gout, there is no reason why the coats of the arteries should not remain normal till advanced life, and then fail as to their elastic elements rather than have the usual atheromatous changes. It would seem to be a more rational view to regard atheroma as an **unnatural** condition, predisposed to by heredity and excited by disease, rather than a **natural** degeneracy of advancing life, which is merely hastened by disease and high blood-pressure. The arguments which lend force to the latter view are the presence of the condition in so many old people, and its preponderance in the male sex, with its heavy muscular work and strenuous recreation.

When present in a marked degree, the arteries have a feeling of "pipe-stems" rather than musculo-elastic tubes, and are almost incompressible. The general circulation is bad, and the patient may suffer from some disease of the organs, such as the heart or kidney, where the condition of the arteries is interfering with their nutrition and function.

The **Treatment** to be adopted is obviously to relieve the blood-pressure. Aperients and nitrites are the drugs indicated, while the diet should be light, with a minimum of meat and absence of alcohol. Severe muscular effort should, if possible, be avoided.

ANEURISM.

An aneurism is a sac formed by the dilated vessel walls, and sometimes by the surrounding tissues, which communicates with the artery and contains blood, fluid or coagulated.

An aneurism may be the direct result of an accident, but more usually it is entirely pathological, or only traumatic in origin in that the injury acts as a predisposing agent in certain persons, or, again, that it acts as an exciting agent in certain predisposed persons.

Pathology.—The conditions which bring about aneurism are a diminished resistance on the part of the vessel walls and an increase in the pressure of the contained blood.

The weakening of the walls is due to atheroma, especially in syphilitic or gouty subjects, starting from within or without; to a contusion, wound, or strain; to an embolus in the smaller arteries. Disease which leads to calcification of the arterial walls is rather against the formation of an aneurism.

The increase of blood-pressure is due to heavy strains or **unusual** exertion. Steady exertion, such as exists in the case of artisans and those who regularly take even violent exercise, does not as a rule lead to aneurism if the walls of the arteries are healthy.

The **sac** of an aneurism consists of one or more coats of the artery, and, as it increases in size, partly of fibrous tissue derived from the surrounding tissues.

The **contents** of the sac differ with the age of the aneurism. If the endothelial lining be complete, merely fluid blood is present. As the sac increases in size, fibrin is deposited layer by layer. If this deposit be of sufficient amount, the cavity may become filled, and a spontaneous cure result. This is, however, a rare occurrence.

The varieties of aneurism are—

1. **Fusiform.**—In which the whole vessel is fairly equally distended, giving a tubular appearance to the tumour. This type is not that generally met with as a result of local injury.

2. **Sacculated.**—The usual type produced by injury, it is formed by a rupture of the inner and middle coats of the artery, the sac wall being formed by the external coat matted together with fibrous tissue.

3. **Dissecting.**—In this type a cavity is formed within the wall of the vessel by the splitting of the middle coat, half of it, together with the external coat, going to form the outer wall of the sac, while the inner one is formed by the inner half of the middle coat with the intima. This cavity gradually increases, the blood entering by a small mouth at the point of severance of the inner and half the middle coats, and burrowing down in the wall of the vessel, and gradually pushing

the external covering outwards to form a prominence on one side of the vessel, while the sound wall on the other side also becomes somewhat bulged.

Signs and Symptoms of Aneurism.—A tumour forms in the course of a vessel which has an expansile pulsation synchronous with the

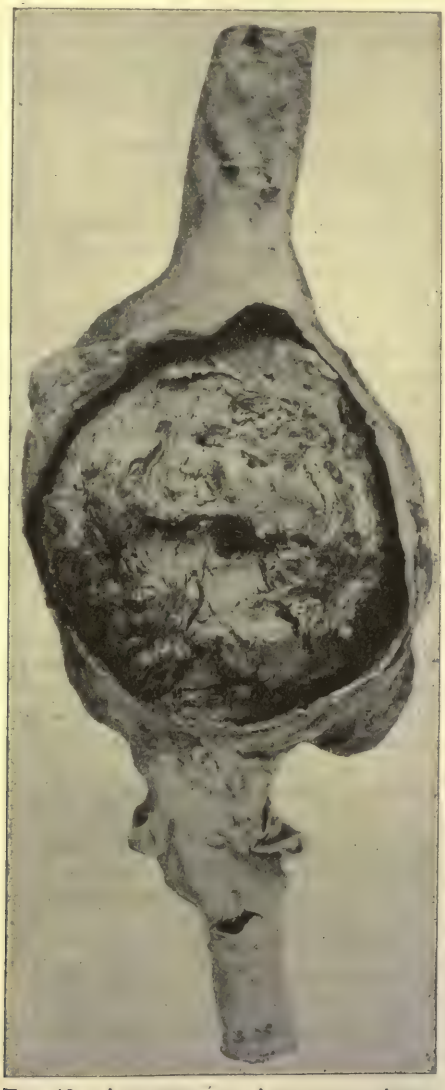


FIG. 40.—ANEURISM OF ABDOMINAL AORTA.
(Beattie and Dickson, "Special Pathology.")

beat of the heart. Compression of the proximal side of the vessel produces diminution in the size of the tumour, while compression of the distal side increases the tenseness of the tumour and the intensity of the pulsation. A bruit, usually of a loud, harsh character, is heard on auscultating the tumour. The pulse in distal vessels is decreased.

The vitality of the limb may be affected by pressure on collateral vessels, and congestion may be produced by pressure on the veins. Various other pressure results may occur according to the situation of the aneurism. Thus bone may be eroded, tubes, as the trachea and œsophagus, pressed upon, and neuralgic pains caused by pressure on nerves. Hypertrophy of the heart is also usually present.

Emboli may be detached from the fibrin layers in the cavity, and lead to gangrene of a limb or to death by blocking cerebral vessels. On the other hand, emboli may lead to spontaneous cure by blocking the entrance to the sac.

Diagnosis.—Aneurism has to be distinguished from a tumour or an abscess situated in close proximity to an artery, from which it derives pulsation, by the impulse being heaving in character, and ceasing when the tumour is lifted up from the vessel; by the size of the tumour remaining unaltered when the artery is compressed; and by the pulse below the tumour remaining normal.

A pulsating sarcoma is distinguished by its being adherent, less circumscribed, and by its being little affected by pressure on the vessel above. Moreover, it often exists somewhat away from the line of the artery, and the consistency of the tumour is variable.

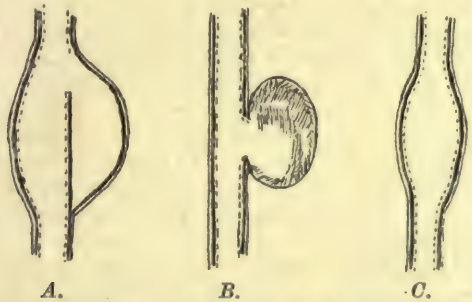


Fig. 41.—*A*, Dissecting Aneurism; *B*, Sacculated Aneurism; *C*, Fusiform Aneurism.

(After Rose and Carless.)

A tumour of the trachea is distinguished by its rising and falling during the act of deglutition.

Almost any artery in the body may be the seat of aneurism. Traumatic aneurism is not common in the great internal vessels when they are healthy. The most usual sites for the traumatic variety are the **subclavian,** the **gluteal,** and the **sacral** arteries. The former is seen frequently in soldiers and sailors, especially the latter, who—at any rate, in sailing-ships—are constantly liable to sudden jerks of the outstretched arm. A sarcoma in the subclavian triangle is diagnosed from an aneurism of the subclavian artery by its pulsation being more diffuse and by the fact that a definite tumour can be felt which is more or less unaffected by compression of the proximal end of the artery, while the impulse in the distal arteries is normal.

The diagnosis from sarcoma in the case of aneurism of the gluteal and sciatic arteries is more difficult. The aneurismal bruit heard on auscultation helps to distinguish them.

Prognosis.—This is always grave. If an aneurism occur in a man with degenerate arteries, it is an added source of danger to life, and

even in a purely traumatic case there always exists the risk of rupture of the aneurism. It often happens that a patient is unaware that the disease exists, and the post-mortem examination may reveal the fact for the first time. Spontaneous cure of aneurism may occur by gradual obliteration of the sac, by thrombosis, or by inflammatory process; but such a result is unlikely in one leading a strenuous life, especially where sudden strain is constantly met with in the course of occupation.

Course and Terminations—1. **Natural Cure.**—This may be brought about by the formation of a laminated blood-clot, which gradually fills the sac. A portion of the clot may break off and plug the artery beyond, leading to thrombosis and cure in that way, or the sac may press upon its feeding artery. If natural cure is proceeding, the sac becomes smaller and firmer, while it is less easily compressed, and there is less expansile force. The murmur and thrill disappear, and the pressure symptoms diminish.

2. **Pressure Fatality.**—Fatal pressure may be exerted by the sac on important structures.

3. **Rupture.**—This may occur through the skin, into a mucous or serous cavity, or into the cellular tissue. At first the bleeding is slight, but it soon becomes so profuse as to prove fatal, except when it is into cellular tissue, when diffuse pressure is caused by the extravasated blood. When rupture occurs, there is sudden and severe pain, and the patient becomes collapsed. If the extravasated blood be small in amount, there will be alteration in the size and shape of the sac. The treatment is that for a ruptured artery.

4. **Suppuration.**—This may occur near an aneurism from infection of the surrounding tissues. The sac of the aneurism usually sloughs, and bleeding occurs into the abscess cavity. Great care should be exercised not to open the abscess before the artery is dealt with.

Treatment of Aneurism.—The aim of treatment is to further the coagulability of the blood, and thus promote the filling of the sac by laminated clot, and to obtain occlusion of that part of the artery which is the site of the aneurismal dilatation without interfering seriously with the nutrition of the part supplied by it.

1. **Constitutional Treatment.**—Perfect rest, mental and physical; an almost dry diet, which should be reduced to the smallest amount possible—say, bread 6 ounces, meat 2 ounces, and milk 6 ounces daily; potassium iodide in large doses to reduce blood-pressure by depressing the action of the heart; saline purgatives should be given to reduce tension and avoid the possibility of constipation, as straining at stool is to be particularly avoided. Pain and restlessness may call for opiates, which should only be given in small doses. If this method is of no avail, local measures should be adopted.

2. **Local Treatment.**—This is very various, and may consist in—

Compression of the artery above the aneurism by means of digital pressure reinforced by weights, or by various forms of tourniquet The object is to promote coagulation gradually or at once. The method is unreliable, painful, and tedious, and is seldom now employed.

Flexion.—When a small, slowly growing aneurism exists at the bend of the elbow or knee, the circulation may be slowed and coagulation promoted by flexing the joint in order to exert pressure on the artery by means of the sac. Before flexing, the limb is bandaged as far as the aneurism. The flexion is kept up for several hours. This treatment is usually combined with other methods.

Reid's Method.—An Esmarch's elastic bandage is applied firmly from below as far as the aneurism, passed lightly over it, and tightened above. The bandage should not be kept on for more than an hour, but digital pressure is maintained for several hours after its removal to guard against the washing away of the clot formed by the sudden re-establishment of the full circulation. The method is not good. It may rupture the sac, or produce thrombosis of the collateral vessels, with resulting gangrene.

Introduction of Foreign Bodies.—This method is only resorted to in inoperable cases, and is used to induce coagulation.

(*a*) *Macewen's Needles.*—These are needles of highly tempered steel, which are passed into the sac and made to touch its opposite wall; they scarify the lining of the sac by means of the pulsation of the blood in the aneurism.

(*b*) *Electrolysis.*—Needles attached to the positive pole of a battery are passed in and allowed to scarify the walls, thus combining Macewen's method with galvano-puncture.

(*c*) The *Moore-Corradi Method* consists in passing piano-wires through a hollow needle into the sac. If it be insulated and the wire attached to the positive pole, and the negative placed on the patient's back, a current of about 50 milliampères may be passed. The wire is left in position, and a clot is formed around it.

(*d*) *Subcutaneous Injection of Gelatine.*—Gelatine in solution increases the coagulability of the blood, and 4 ounces of white gelatine in sterilized water at about 100° F. injected every other day sometimes effects a cure. No change is seen for about a fortnight, and the first clot may soften and disappear.

Extirpation of Sac—(*a*) "*Old Operation*" *of Antyllus* (A.D. 300).—This consists of cutting into the sac, clearing out clots, and tying the artery above and below, when the sac may be taken away or left behind, when it is possible to do so. A tourniquet should be applied before beginning the operation, or the artery plugged by a finger inserted into the sac after incision.

(*b*) *Matas' Modification.*—The sac is obliterated by stitching through the middle and outer coats, except that portion which corresponds to the normal lumen of the vessel, the empty sac is then folded over the line of suture.

Amputation.—When the aneurism is the seat of recurrent hæmorrhage after ligature, or of suppuration, amputation may be called for.

Ligature of the Artery.—Unless contra-indicated or impossible of accomplishment, this, as the procedure of choice, divides the palm with extirpation of the sac, or Matas' modification. It is an easier procedure, and more simple than the latter, though, perhaps, not so certain and effective.

The material used for ligature may be silk, catgut, or tendon.

The operation may be done in four ways:

(*a*) *Proximal Ligature by Anel's Method.*—The artery is ligatured on the cardiac side of the aneurism, immediately above the sac. This method is effective, but very difficult, owing to the altered anatomical relationship of the vessels, and to the fact that the walls may be unhealthy.

(*b*) *Proximal Ligature by Hunter's Method.*—The artery is ligatured at some distance from the sac. This has the advantage of having unaltered relationship of the vessels and healthy walls to deal with, but its disadvantage is the uncertainty of efficiency, since the collateral

circulation may be so free as to render the aneurism practically unaffected by the operation.

(*c*) *Distal Ligature by Brasdor's Method.*—This consists of ligature of one or more branches, so as to completely stop circulation through the aneurism.

(*d*) *Distal Ligature by Wardrop's Method.*—This consists of ligation of some branches of the artery so as to limit the amount of blood passing through the aneurism, and so promote coagulation.

The distal ligature is suitable for cases in which the proximal ligature cannot for any reason be applied.

In ligaturing an artery **in its continuity,** an incision is made in the long axis of the vessel. The artery being exposed, with as little disturbance of the parts as possible, the sheath is carefully opened for a short distance, and an aneurism needle passed unthreaded from the side having the most important structures adjacent. The thread is inserted and the needle withdrawn, the operator retaining the loop of the ligature around the vessel. The loop is then divided, making two ligatures, which are each tied in the first turn of a reef-knot, and then the two ends on each side are used as one cord to complete a reef-knot (stay-knot).

ARTERIO-VENOUS ANEURISM.

This is an abnormal opening between an artery and a vein. There are two varieties :

A. *B.*

FIG. 42.—*A*, ANEURISMAL VARIX; *B*, VARICOSE ANEURISM.
(After Rose and Carless.)

Aneurismal Varix, in which the opening into the vessels is direct, due usually to trauma, in old times a frequent result of the operation of bleeding from the median basilic vein at the bend of the elbow, when the brachial artery was also opened. Nowadays it is due to stabs and gunshot injury penetrating both vessels. The higher pressure in the artery forces blood from it into the vein, which becomes dilated and forms a thick-walled sac, beyond which the vessel is implicated, and its tributaries become distended and tortuous.

The condition is evidenced by a varicose condition of the vein, but it is distinguished from ordinary varicose veins by the arterial impulse, communicated by the blood being forced from the artery, which is accompanied by a fairly loud murmur.

The **treatment** will resolve itself into support with an elastic bandage in the great majority of cases, but occasionally operative treatment is required to relieve the symptoms. This consists in exposing the affected vessels, and after separating them, closing each with one or more sutures. The operation is not an easy one, and may be followed by gangrene. Sometimes it is necessary to ligature the artery above and below the communicating point as an alternative operation.

Varicose Aneurism, in which the opening is not direct, but through a sac. The condition is often found associated with a traumatic aneurism. The sac is formed of neighbouring tissues matted together, and is usually present before the opening into the vein occurs.

The symptoms are partly those of the foregoing variety and partly of an aneurism.

Treatment is frequently called for to prevent extension of the aneurism, with possible rupture into the vein. It consists in ligation of the artery above and below the sac, with incision of its walls, the turning out of clots, and the ligature of feeding vessels. It is not as a rule necessary to ligature the vein.[1]

VARICOSE VEINS.

Varicose veins are caused by those occupations which necessitate prolonged standing or a great amount of slow walking. The long column of blood, especially in the internal and external saphena veins, those most often affected, overcomes the support of the valves, and the walls gradually become distended and stretched, till at length the direction of the vein is tortuous instead of straight.

Pressure from a tumour, etc., may start the condition. Congenital defect seems to play a part, since the condition is found in successive generations, and it is probable that, but for some predisposing cause, varix would not develop merely from occupation. The essential point in the production of a varicose condition in the lower extremity is inefficiency of the venous valves to control the backward pressure thrown upon them by the column of blood, and that this operates chiefly on the saphena veins is to be explained by the facts that they support the foot of the column, and that normally the internal saphenous vein has to bear considerable back pressure, owing to the valves of the venous system above it being rudimentary.

Symptoms.—Weight, fulness, and pain are complained of in proportion to the pressure in the veins, and the length of vein involved. As a rule, the condition can be easily seen, unless when œdema is present in a marked degree. Dilatation is usually most marked between the middle of the calf and the middle of the thigh, while bunching of veins may occur at the knee and ankle, and enlarged communicating branches form between the internal and external saphena veins near the popliteal space or across the shin.

Trendelenburg's Test.—The patient is placed in the recumbent position, and the limb elevated to empty the vein. Pressure is then made over the position of the saphenous opening, and the patient allowed to get up, when, if the internal saphenous is alone affected, the veins fill again very gradually from below. If both saphena be involved, the veins fill more quickly; while if the pressure be

removed from the saphenous opening, the veins fill rapidly from above.

The **Late Effects** of varicose veins are—

Ulcers, often started by the irritation of a dirty garment on the swollen vein and the tender skin covering it. This ulceration, once started, is wellnigh impossible to cure—at least, while the patient continues at work necessitating standing. The condition produced in the limb by the vein may be such as to oblige a patient to give up the particular occupation at which he is engaged.

Pigmentation of the skin often precedes ulceration.

Rupture of a varicose vein may arise from injury, and if not promptly treated, will lead to death from hæmorrhage, and, short of this, to profound anæmia.

Chronic Eczema occurs from lack of proper nutrition of the skin.

Phlebitis and **Thrombosis** are common, and may give rise to embolus. Occasionally a cure results from the thrombus becoming organized.

Treatment.—(i.) In early cases the removal of pressure and the avoidance of any posture apt to cause and perpetuate the condition, together with the use of a woven silk or porous elastic bandage applied before getting up in the morning, will probably prevent the condition from getting worse.

When more advanced, or for reasons of expediency, operation is called for, there are various forms, all of which aim at the obliteration of the involved vein.

(ii.) The old method was to remove the most distended portion of the vein through one incision.

(iii.) Trendelenburg advocated the removal of 3 or 4 inches of the internal saphenous vein in the upper part of the thigh after a ligature has been placed at the top and bottom of the exposed portion. In this operation all tributary branches should be tied, and any which are enlarged removed. Recurrences are frequent after this method.

(iv.) The usual plan nowadays is to remove the entire internal saphenous vein by one method or another.

(*a*) Kennedy of Glasgow advocated the removal of the vein by one long incision. Such an incision is unnecessary and dangerous.

(*b*) A. B. Mitchell and Fullerton have described a method by which the whole vein is removed by small multiple incisions. The vein is exposed where near the saphenous opening, and the vessel clamped and divided. Its upper end is then ligatured. Multiple incisions are made in its course, which is made evident by pulling on the distal end, and the vein, having been clamped at each exposure, is drawn from the one above it, thus removing the whole vein. Large varicose branches are treated in a similar way. The incisions are then united by stitches. This method gives very good results, but is tedious in its performance.

(*c*) Mayo uses a "vein-stripper" to remove the vein, which is exposed and ligatured at the upper third of the thigh. It is then divided, and the lower end is threaded on to the ring of the stripper, which is gently pushed down the bed of the vein, which it tears away, together with its branches. A second incision gives exit to the instrument, and, if necessary, the process is repeated.

This method is not a good one when the veins are brittle. Various other instruments have been evolved for a similar purpose.

(*d*) Babcock advocates the use of an "extractor," which is a thin steel rod 26 inches in length, having different-sized pyramidal projections at

either end. Grey uses the instrument in screwing sections. The vein being exposed and ligatured near the saphenous opening, the smaller end of the rod is inserted into the distal end of the vein, and passed along its course to the ankle, where it is cut down upon and drawn through. Traction is now made, and the larger upper end of the rod pulls the vein from its bed, tearing the branches as it comes to them, and appears at the lower incision with the vein in closely placed folds around the rod under its head. If the instrument does not pass all the way at first, the operation can be done in two sections. This method is very quick, and results have been satisfactory, though there is a little risk of hæmorrhage and embolism.

For **Tumours of Bloodvessels,** see Tumours (Chapter VIII.).

CHAPTER XVI

INJURIES AND DISEASES OF THE LYMPHATIC SYSTEM

Injuries: Wounds, rupture—Diseases: Lymphangitis, lymphangiectasis, lymphadenitis, leucocythæmia, malignant disease.

INJURIES OF THE LYMPHATIC VESSELS.

Small lymphatic vessels are divided in wounds, and the escaping lymph forms part of the discharge, but is not as a rule recognized. If, however, larger trunks are injured, the contained lymph may be recognized as a colourless fluid of watery consistency, and gives rise to the condition known as "lymphorrhagia," while the wound leading to the lymphatic is termed a "lymphatic fistula." The discharge of lymph ceases when new channels are formed for it. This usually occupies about four weeks. When the lymphatics of the limb have been much interfered with, œdema may occur.

Wounds of the left thoracic duct are, of course, the most serious. They usually occur when dissecting out a mass of glands at the root of the neck. The accident may be evidenced at the time of the injury by the rhythmic discharge of jets of white fluid, or it may not be noticed at the time, but is evidenced later by the dressing being soaked with chyle, and, in those cases where only one main duct exists, by prostration, great thirst, and emaciation; death may supervene. In most cases, however, the discharge ceases spontaneously, and collateral circulation is established. A tumour sometimes forms, owing to the chyle being unable to escape. The usual procedure is to tie the injured vessel, since it is not possible, as a rule, to reunite it so that the lumen is not interfered with. After such an accident, a diet rich in fats should be ordered.

A smaller duct exists on the right side, but wounds of it are of little import.

Rupture of the thoracic duct occurs sometimes in crushing of the thorax, and is referred to in Chapter XXIV.

DISEASES OF LYMPHATIC VESSELS.

Lymphangitis.—This is an inflammation of the lymphatic vessels, set up, as a rule, by the entrance of pyogenic organisms or their toxins from a primary source of infection in the skin. The organism usually found is the *Streptococcus pyogenes*. The walls of the vessels are affected, and this leads to clotting of the lymph. The inflammation usually spreads to the surrounding cellular tissue, setting up peri-

lymphangitis, while abscess formation may take place along the course of the vessels.

Symptoms.—Irregular, red lines run from the source of infection towards the nearest lymphatic glands. These indicate the affected vessels, and over them there is pain, heat, and tenderness. The nearest glands are as a rule painful and enlarged. The temperature and pulse-rate are raised according to the severity of the case. If the lymphatics involved are deep, there will be œdema of the limb, and the red lines will be absent.

It is not as a rule possible to distinguish clinically the tuberculous from the septic type. It occurs associated with certain skin lesions, as lupus. The infection spreads along the superficial vessels, which become thickened and nodular. Some of these nodules may form the starting-point of an abscess; if the lymphatics are widely involved, œdema of the limb occurs. In primary syphilis, the lymphatics on the dorsum of the penis are indurated, but the condition scarcely merits the distinct name of "syphilitic lymphangitis" sometimes applied to it.

Cancer cells are conveyed by the lymphatics from the primary growth to the glands, and may themselves become the seat of malignant growth, forming nodular cords.

Treatment.—The source of septic infection is treated in the usual way, after which the lymphangitis usually abates. If, however, the condition goes on to suppuration, the pus must be liberated. Bier's hyperæmic treatment by elastic bandages or suction bells may be carried out, or vaccine injections made from cultivations of the streptococci in the pus. After-treatment by means of massage and bandaging prevents œdema.

When the lesion is tuberculous or syphilitic in origin, the treatment is that of the causative agent.

When malignant, the affected vessels should be removed with the primary growth and the neighbouring glands.

Lymphangiectasis.—This is a varicose condition of the lymphatics, sometimes congenital in the tongue and lips (macroglossia, macrocheilia); sometimes acquired, as the result of any condition which causes blocking of the main trunks, as deposit of tuberculous or cancerous material in the vessels or glands; and repeated attacks of lymphangitis.

A common cause of blocking met with in those who have resided in Egypt, the West Indies, etc., is the presence of the *Filaria sanguinis hominis* in the vessels, giving rise to **elephantiasis arabum** (Barbadoes leg), and the results are observed principally in the groin, the spermatic cord and scrotum, and the legs. In the groin the disease is indicated by a soft swelling of varying size, which partly disappears on pressure, or when the patient is in the recumbent position. There is a history of exacerbation of symptoms when the swelling increases and becomes painful. The tumour, on examination, is found to be composed of dilated, twisted, and thickened lymphatic vessels, in which the parent worm may be found, and of enlarged lymphatic glands converted into spongy tissue, the spaces being filled with lymph. The fluid found in the vessels may be clear or turbid.

The condition may be associated with **lymph scrotum,** in which the scrotum may be so enlarged as to hang to the ground: **elephantiasis of the legs,** which swell to an enormous extent; and **chyluria.**

Diagnosis.—The condition has to be distinguished from hernia and from lipoma. The finding of the embryo is, of course, diagnostic.

Treatment.—If the condition is localized, cure may follow excision; when generalized, operation is not advisable. Ligature of the main artery has been sometimes attended with good results.

For **Tumours of Lymphatic Vessels** (Lymphangiomata), see Tumours (Chapter VIII.).

DISEASES OF LYMPHATIC GLANDS.

Acute Lymphadenitis (Inflammation of Lymphatic Glands).—This is usually secondary to a septic lesion in the skin area associated with the adenitis, and the lymphatic vessels conveying the toxin may also be affected. The glands become swollen and matted together, periadenitis supervenes, and the whole gives rise to a diffuse inflammatory swelling with early abscess formation in the more acute, septic forms. The predisposing cause differs with the situation. In the submaxillary region it is disease of the mouth, tonsils, or teeth; in the posterior triangle of the neck, diseases of the scalp, pediculi, ulcers, or wounds; in the axilla, septic conditions of the breast or arm; in the groin, like conditions of the genital organs, abdominal wall, perineum, and anus—in the latter case it is the oblique glands which are usually affected—or sepsis of the inner side of the leg; in the popliteal space, to septic conditions of the outer side of the leg and the foot.

Treatment.—The source of infection should be sought for and removed, when the more indolent forms will clear up. In the septic forms suppuration should be avoided, if possible, by the use of Klapp's suction bells. If suppuration take place, an incision should be made, and the bell again applied. If an abscess has formed, it should be freely opened, and a drainage-tube inserted.

Chronic Lymphadenitis.—This is generally due to either tubercle or syphilis. A simple form is described, but it is doubtful if any chronic enlargement of the glands exists other than that due to one of the above diseases. What is called simple is probably of the non-active tuberculous type.

Tuberculous Adenitis.—This occurs in children and young adults, and is an exceedingly common disease. The bacillus may gain access to the glands in various ways—through the lymphatic vessels draining the skin surface with which they are associated, through decayed teeth and sometimes through the blood-stream. Any of the glands of the body may become the seat of disease, but those most frequently affected are the groups in the neck, the submaxillary, carotid, and supraclavicular, in the order of frequency named. The axillary and inguinal glands are less often affected. This is probably owing to the fact that the groups in the neck drain the lymph from the mouth, nose, throat, ear, and scalp, which are all liable to infection. The chief predisposing causes are bad hygienic surroundings and poor nutrition, decayed teeth, presence of adenoids and enlarged tonsils, middle-ear trouble, and pediculi. The glands may be the seat of secondary deposits of tubercle, as when those in the axilla become enlarged in tuberculous disease of the breast, ribs, sternum, or fingers.

Pathology.—The glands at first are enlarged, but present no other external abnormality. Under the microscope, however, giant cells and bacilli can be seen. Later there is infiltration and caseation,

which may result in calcification or cicatrization, or go on to suppuration. This may be of a tuberculous or mixed type. Periadenitis occurs before long, and causes adherence of the glands to one another, and to the surrounding tissues.

Signs.—In the first stage there is simple enlargement without much tenderness, the glands remaining separate. The next stage is that of periadenitis, in which the glands and the surrounding tissues become matted together. The final stage is that of suppuration, a cold abscess is formed, which may break through the skin, leaving chronic sinuses, which, if they heal, leave characteristic puckered scars.

Diagnosis.—Tuberculous adenitis has to be distinguished from septic enlargement of glands, lymphadenoma, and lympho-sarcoma. This may be done by the history and by applying tuberculin tests. Later on, when suppuration has occurred, the tuberculous nature of the disease is further indicated. The diagnosis from secondary cancer may be made by the association of the latter with cancer of an adjacent part. The cold abscess resulting from tuberculous adenitis should be distinguished from cystic swellings and from abscess secondary to tuberculous disease of the cervical vertebræ.

Treatment.—When seen early, all sources of irritation should be removed, and the patient put on tonic treatment. When there are signs of liquefaction limited to one gland, the pus may be drawn off through a hollow needle, and the cavity filled with iodoform emulsion. If suppuration has occurred, with matting together of the tissues, the abscess should be opened, scraped, and packed with iodoform gauze. Subsequent to this, injections of tuberculin, bacillary emulsion, should be given at intervals of a week or ten days, beginning with $\frac{1}{30000}$ milligramme. Especially in cases which have broken down, or where the glands are much matted together, this is probably the best mode of treatment.

In the earlier stages the complete operation for removal of the cervical glands may be undertaken. If this is done, the skin incision should be large enough to enable the affected area to be reached, and, in order to avoid disfigurement, the incision should be made so far as possible in the lines of the natural creases of the neck, or below the jaw, or beyond the sterno-mastoid. The operation is often a very extensive one, and may involve division of the sterno-mastoid or resection of the internal jugular vein. Particular care should be taken not to injure the spinal accessory, vagus, or phrenic nerve. Since the introduction of the tuberculin vaccines, extensive operations for the removal of infected glands are much less frequently undertaken than formerly was the case.

When the glands of the groin are affected, it is usually in the femoral chain, and follows tuberculosis of the skin of the toes or sole of the foot. It is characterized by early suppuration and involvement of the skin. There may be considerable bleeding from tributaries of the common femoral. The glands and injured skin should be removed.

Tubercle may infect various other glands, as the mesenteric and bronchial, and is referred to elsewhere.

Syphilitic Adenitis.—Enlargement of lymphatic glands occurs in primary syphilis as the bullet bubo, which accompanies the hard chancre; in secondary syphilis, as a general adenitis throughout the body; and in tertiary, especially when the disease is hereditary, as gummata of the glands. The latter is, however, rare.

Treatment.—Antispecific.

Leucocythæmia.—A disease of the blood-producing organs and of the blood, characterized by great increase in number and alteration in character of the leucocytes. It is associated at times with great enlargement of the cervical glands and considerable constitutional symptoms, and so may come to simulate Hodgkin's disease. The condition is frequently a symptom of other diseases rather than a distinct entity.

Malignant Disease of Glands—Lympho-Sarcoma.—This is really a sarcoma which starts in the glandular tissue. It is most frequently met with in the neck or axilla as a rapidly growing tumour, composed of one greatly enlarged gland, with a number of small ones grouped round it. The tumour breaks through the capsule, and involves the surrounding tissue and skin. It is intensely malignant in character.

Treatment.—Early removal, followed by the employment of the X rays.

Secondary to Malignant Disease.—This is very common. It is met with in the neck following epithelioma of the tongue, lips, or throat; in the axilla, following scirrhus of the breast; in the groin, following epithelioma of the penis, scrotum, or vulva; or as large femoral pigmented tumours following melanotic cancer of the sole of the foot. In the latter condition the enlargement of the glands is out of all proportion to the size of the original focus of the disease.

For **Tumours of Lymphatic Glands,** see Tumours (Chapter VIII.).

CHAPTER XVII

INJURIES AND DISEASES OF NERVES

Injuries: Contusion, rupture, compression, reaction of degeneration, results of division, primary and secondary suture, injuries to special nerves—Diseases: Neurosis, neuritis, neuralgia, sciatica, trigeminal neuralgia.

INJURIES OF NERVES.

Contusion or Strain.—The most common form of injury is a strain, which causes a sensation of tingling. In severe cases of contusion there may be a resulting loss of function due to hæmorrhage in the nerve sheaths, and in certain neurotic subjects neuralgia may be set up. In the gouty and syphilitic chronic neuritis may result.

Concussion.—The high velocity bullets now used may cause concussion of nerves from the high degree of compression of the air without any direct injury of the nerve by a bullet. In the case of a wounded officer in the present war the bullet passed near the great sciatic nerve and caused entire loss of function which lasted for several months. Massage and the galvanic current are the best means for restoring function.

Rupture.—This form of injury is most likely to occur to a nerve in fracture of bone. It may be complete or incomplete. It is unusual to find, even if the nerve be torn, that the sheath has given way; hence repair often takes place. If the sheath be also ruptured, no repair can occur unless an operation for nerve suture be performed.

Symptoms.—Paralysis of the part supplied by the injured nerve, combined with loss of sensation, which gradually pass away if repair takes place.

Treatment.—Expectant, if it is seen that the nerve is ruptured. If at the end of fourteen days the reaction of degeneration be present, operation should be undertaken.

Speaking generally, treatment of nerve lesions not requiring operation is comprised in keeping the parts warm and secure from injury, and employing massage, douching, and the electric current.

Compression of Nerves.—As a result of the nerve being included in ensheathing callus, or owing to pressure by tumours, spasm and neuralgic pains, and later paralysis and loss of sensation are met with. Amongst other forms of compression are those caused by sleeping with the arm over the back of a chair or on the edge of a table, producing pressure on the nerves of the arm, particularly the musculo-spiral nerve, known as "drunkard's palsy"; and "crutch palsy," from the pressure in the axilla by the head of a crutch or by a tourniquet.

When compression is gradual, the normal electrical reactions are as a rule preserved; but when the injury is severe and instantaneous, the reaction of degeneration is usually present after the first week.

By **Reaction of Degeneration** is meant the failure of the muscle to react to the interrupted current, and the different type of contraction given with the constant current.

Complete Division—Motor Changes.—If complete division of the nerve and sheath occur, not only is there paralysis, but the muscles supplied by the injured nerve rapidly waste and give the reaction of degeneration, after a few weeks they lose altogether their electrical reactions. The paralyzed muscles either gradually undergo fatty degeneration, or are transformed into fibrous tissue, thus giving rise to a deformity known as " paralytic contracture."

Sensory Changes.—There is complete loss of sensation over the area supplied by the nerve, although sensation may partially return after a time owing to collateral supply.

It is well to remember, in referring to loss of sensation, that three sets or systems of afferent fibres are now recognized, giving rise to a threefold sensibility:

1. *Epicritic Sensibility*, the most highly specialized, which appreciates light touches and fine differences of temperature, and can discriminate between the points of a pair of compasses 2 centimetres apart.
2. *Protopathic Sensibility*, which responds to painful cutaneous stimulus or extreme heat and cold, and endows hairs with sensibility to pain.
3. *Deep Sensibility*, which responds to pressure. The fibres run with the motor nerves, and are distributed to muscles, tendons, and joints (Head, Sherren, Rivers).

Vasomotor Changes.—After section of a nerve there is a slight rise of temperature of the part which it supplies, followed shortly by a fall, the latter being greater than the former, and may amount to 10°. The parts become cold and blue, this being more marked in cold weather.

Trophic Changes.—After a time the skin usually becomes dry, withered, and smooth—occasionally œdematous and covered with sweat. The subcutaneous tissue disappears, the hair becomes brittle and falls off, and the nails furrowed and frequently break. The skin easily blisters, and may form ulcers. The joints often undergo slow inflammation leading to fibrous thickening of the ligaments with ankylosis.

Central nervous changes sometimes occur, giving rise to such manifestations as epilepsy and dementia. It is hard to understand why these should develop, and no pathological evidence is found to explain them.

Process of Repair.—When a nerve is divided, the ends may remain in contact or become separated. In the former case, so long as the wound is aseptic, union will take place. Union takes place either by the growth of the central axis cylinder downwards to the peripheral termination, nutrition being supplied to the growing tissue by the multiplying cells of the neurilemma, or by the growth of new axis cylinders from both ends, the peripheral one not attaining full development till its union with the central. The former is probably the more correct view.

The new nerve fibres are easily destroyed by any septic process. Thus sepsis will prevent union.

When the ends of the divided nerve are not in contact, union cannot take place. At the proximal end a bulb of nerve tissue forms

which may become adherent to the scar tissue, and still further prevent natural union. This bulb consists of nerve tissue — **traumatic neuroma**—and is caused by active attempts at regeneration by the central axis cylinder. In a stump after amputation they may attain to a large size if sepsis occur, or if the nerves are cut too long, when they will give rise to trouble and require removal. These are known as **stump neuromata.**

Treatment—*Primary Suture.*—When a nerve is separated after division or rupture, it should be united at once. This is referred to as *primary suture,* and should be carried out under the strictest asepsis. A wound should be made, or, if one exists, enlarged in the long axis of the nerve. Having been found, the ends of the nerve should be brought together and united with fine catgut. The sutures should transfix the ends of the nerve and the sheath, and be drawn sufficiently tight to insure proper apposition. Tension should be relieved by flexing the joints and fixing the limb in splints. As soon as the wound is healed and until function is restored, the limb should be protected from injury and cold, and massage employed. The galvanic current will help to restore vitality, and give nutrition to the paralyzed muscles. The time of restoration of function will vary. Sensation will begin to return in about sixty-five days. Motor power and sensibility to light touch will return in a little under a year (Head and Sherren).

Secondary Suture.—By this is meant the operation of joining the ends of the nerve subsequent to the healing of the wound. An incision is made in the line of the nerve, and the ends exposed. Having been freed from the scar tissue, they are trimmed and drawn together by sutures. If it is found impossible to do this, the gap should be bridged by strands of catgut, or a piece of nerve may be used which has been obtained from an animal or from the recently amputated limb of a human patient.

If the gap is too wide for such treatment, **nerve implantation** should be tried. This consists in joining the divided ends with the nearest nerve trunk.

The results of secondary are, of course, not so satisfactory as those of primary suture. Especially is this the case with regard to the return of motor power, owing to the degeneration of muscles which has taken place; but in favourable cases good results are obtained, though a considerable period will elapse before any benefit is seen.

INJURIES TO SPECIAL NERVES.

Injuries to the **cranial nerves** will be considered under Head Injuries.

Brachial Plexus.—Injuries to the plexus may be divided into—

1. **Supraclavicular.**—From indirect violence, as excessive or sudden strain of the arms, as in attempting to prevent a fall. Direct violence, as pressure from a cervical rib, the force that fractures a clavicle, or a stab-wound.

There are three types of injury which may result from indirect violence to the brachial plexus—

(*a*) **Whole Plexus.**—All the muscles of the arm are paralyzed, with the exception of the rhomboids and serratus magnus muscles, and

there may be symptoms of injury to the cervical sympathetic nerve. When the injury is above the clavicle, sensation is lost except at the inner side near the axilla, which region is supplied by the intercosto-humeral nerve. In infraclavicular rupture, sensation is entirely lost.

(*b*) **Upper Arm Type (Erb-Duchenne Paralysis).**—This is due to a rupture of the anterior primary division of the fifth cervical nerve, and is frequently caused by traction on the arm in a **downward** direction. The arm lies in a characteristic position close to the side, with the forearm extended and pronated. There is paralysis of the deltoid, rotators, biceps, brachialis anticus, and supinators, but no loss of sensation. Brachial birth paralysis is of this type.

(*c*) **Lower Arm Type (Klumpke Paralysis).**—This is caused by a rupture of the anterior primary division of the first dorsal nerve, and produced by traction of the arm in an **upward** direction. There is paralysis of the intrinsic muscles of the hand and of the sympathetic nerve, with loss of sensation over the inner side of the arm and the forearm.

2. **Infraclavicular.**—Chiefly due to violence at the time of dislocation of the shoulder and efforts at reduction.

The **Inner Cord** of the plexus may be injured in a subcoracoid dislocation, and produces symptoms of injury to the ulnar nerve and paralysis of the intrinsic muscles of the hand supplied by the median nerve with loss of sensation over the inner surface of the forearm and the ulnar side of the hand.

The **Outer Cord** is sometimes injured by dislocations. There is paralysis of the biceps, coraco-brachialis, and the muscles supplied by the median nerve, except those of the hand.

The **Posterior Cord** is very occasionally injured. There will be paralysis of the muscles supplied by the musculo-spiral and circumflex nerves.

The **Nerve of Bell** (posterior thoracic) arises from the fifth, sixth, and seventh cervical, and supplies the serratus magnus. It may be paralyzed by injury, or as the result of neuritis.

There is paralysis of the muscle, giving rise to "winged scapula," with inability to raise the arm above a right angle.

The **Circumflex Nerve** is usually injured by blows, fractures of the surgical neck of the humerus, or by dislocation. There is paralysis of the deltoid and teres minor muscles.

The Musculo-Spiral Nerve.—Owing to its position, this nerve is very commonly injured.

The causes are usually fracture and dislocation of the humerus, the pressure of a crutch on the posterior part of the axilla, or pressure against the bone in sleeping with the arm on the back of a chair or pressed under the body, or the arm being allowed to hang over the edge of the operating-table. Another common cause is involvement in callus after fracture of the humerus. There is paralysis and wasting of the triceps, supinator, and extensor muscles of the thumb, fingers, and wrist. Drop-wrist is the most outstanding symptom, the hand being in a position of flexion and pronation, and the patient unable to dorsiflex the wrist or fingers, but the terminal phalanges can be partly extended by the interossei lumbricales when the hand is supported. The form of drop-wrist is distinguished from that due to chronic lead-poisoning by inclusion of the supinator longus in the paralysis.

If the lesion is in the upper third of the arm, there will be loss of

sensation over the back of the radial side of the hand and thumb. If the lesion is in the lower third of the arm, there is no loss of sensation, since the external cutaneous branches of the musculo-spiral nerve anastomose with the external cutaneous nerve, which nerve anastomoses with the radial nerve.

Radial and Posterior Interosseous Nerves.—As well as being involved in injury of the musculo-spiral, these nerves may be involved in dislocations or in fracture of the neck of the radius. Injury to the radial nerve in the upper two-thirds of the arm produces no loss of sensation, for the reason given above. In the lower third there is loss of sensibility in the radial side of the hand. Wounds of the dorsal surface of the wrist and forearm may be followed by loss of sensibility over a greater area, since the musculo-cutaneous nerve is also divided and some fibres of the inferior external cutaneous branch of the musculo-spiral nerve.

Median Nerve.—This nerve is usually injured by wounds above the wrist. There is paralysis of the three short thumb muscles—the abductor, opponens, and part of the flexor brevis—and of the outer two lumbricales.

The paralysis of the opponens pollicis is shown by the inability to carry the thumb across the hand in a parallel direction to the palmar surface. There is loss of sensation of the palmar aspect of the thumb and of two and a half outer fingers, and on the dorsal aspect of the last two phalanges of the same fingers. **Deep sensation is not lost unless the tendons are also cut.** Trophic changes may be present.

If the nerve be injured at the elbow, there is paralysis of both pronators and of all flexors, except that part of the flexor profundus and the flexor ulnaris which are supplied by the ulnar nerve. Deep sensation is more likely to be lost after injury in this situation.

The Ulnar Nerve.—Usually injured by wounds or dislocations in the region of the elbow-joint or just above the wrist.

When injured at the elbow, there is paralysis of the flexor carpi ulnaris and half the flexor profundus, of all the interossei and the two inner lumbricales and the adductors of the thumb. The hand has a characteristic attitude, with hyperextension of the metacarpo-phalangeal joints, and flexion of the two interphalangeal joints, producing the clawlike hand (*main en griffe*). There is usually wasting between the metacarpals. There is also paralysis of the adductor muscles of the thumb, shown by inability to bring it against the index-finger in a direction at right angles to the palmar surface. There is wasting of the thenar and hypothenar eminences.

There is loss of epicritic sensation of the little and half the ring fingers on both sides; also of the ulnar side of the hand. Loss of protopathic and deep sensation are usually limited to the little finger.

If the nerve is injured just above the wrist, paralysis of the hand alone is seen, and there is no dorsal loss of sensation. When divided below the point at which the dorsal branch is given off, the loss of sensation is not marked, and the injury may be overlooked at first. Typical claw-hand is seen. When injured above the dorsal branch, the loss of sensation is similar to that following injury at the elbow, but that deep sensibility usually remains unless the tendons as well as the nerves are divided.

In treating these cases, special care must be taken to wear a splint until the muscles regain their power, when special movements should be begun.

The Cauda Equina.—It may be injured by falls or blows, as a part of a spinal injury, or independent of it. There may be paralysis of the muscles supplied by the various nerves of the sacral plexus. These are—

By the fourth lumbar, the posterior muscles of the leg below the knee and the tibialis anticus.

By the fifth lumbar, the anterior muscles of the leg, except the tibialis anticus and the peronei muscles.

By the second sacral, the glutei and hamstrings.

By the third and fourth sacral, the levator and sphincter ani muscles and the perineum.

The loss of sensation is usually limited to the buttocks. The protopathic loss is greater than the epicritic.

The Sciatic Nerve.—This nerve is seldom injured, owing to its deep and protected situation. The symptoms are those of injury of the internal and external popliteal nerve, together with paralysis of the hamstrings.

External Popliteal Nerve.—May be injured as it passes round the neck of the fibula. The chief symptom is "drop-foot," owing to paralysis of extensor and peronei muscles. Protopathic and epicritic sensibility is lost over the dorsum of the foot; deep sensibility is unaffected. Later on trophic sores may develop, and the foot take on the deformity of equino-varus.

Internal Popliteal Nerve.—This nerve is very seldom injured. When it is, there is paralysis of the calf and flexor muscles of the toes, and anæsthesia of the sole of the foot, and talipes calcaneo-valgus may develop.

DISEASES OF NERVES.

Traumatic Neurosis.—This may be the result of contusion and compression, as from the head of a bone after dislocation pressing on a nerve trunk, or it may follow a wound near a nerve, as when one is involved in scar tissue subsequent to an operation.

There occurs an overgrowth of the connective tissue, which causes pressure on the nerve fibres, and sometimes ends in their degeneration.

Some time—it may be weeks or months—after an injury there occurs hyperæsthesia and neuralgic pains in the course of the nerve, which becomes very sensitive, and may be felt as a swollen cord if it be sufficiently superficial. The muscles supplied by the nerve become wasted, lose their power, and may be subject to convulsive twitchings. Total loss of sensation or complete paralysis is rare.

Treatment.—Constitutional, predisposing causes, as gout, syphilis, diabetes and alcoholism, should be treated, and symptoms relieved by rest to the part, and soothing applications, such as belladonna and glycerine, by hot-air baths, and, when persisting, by blistering or the actual cautery. Stretching of the nerve is sometimes beneficial.

Multiple Peripheral Neuritis.—The most common cause is alcoholism. It may also be due to diabetes, chronic lead or arsenic poisoning; to the action of certain organisms, as those of diphtheria, venereal diseases, typhoid, and influenza; and to tropical disorders, as leprosy and beriberi.

The distribution will vary with the cause.

There is a degeneration of the conducting fibres of the nerves affected. The motor symptoms are weakness, sometimes amounting to paralysis, wasting, loss of reflexes, and the reaction of degeneration. The sensory symptoms are pain and tenderness along the course of the nerve. In alcoholic neuritis the muscles are markedly tender, there is numbness and tingling, but seldom complete loss of sensation.

Treatment.—The medical treatment for the particular disease present. The surgical treatment consists in preventing deformities by suitable splints, etc. Massage and the galvanic current are employed later to improve nutrition.

Neuralgia.—This condition may be included here, though whether it is to be regarded as a nerve disease is not very clear.

The cause is uncertain, and the term is applied to pain which follows the course of some particular nerve, but is not due to any ascertainable cause.

The neuralgias which commonly come under the hands of the surgeon are sciatica and trigeminal neuralgia.

Sciatica.—This is a symptom rather than a disease. It is a term applied to neuralgia or neuritis of the great sciatic nerve. The condition may be **primary** or **secondary**.

Of **primary sciatica** gout is the commonest cause. More rarely infections—syphilis, gonorrhœa, or influenza—are responsible, whilst bilateral sciatica is sometimes a symptom of diabetes. The disorder is frequently preceded by lumbago, and is marked by pain along the sciatic trunk.

In *neuralgic* varieties pain is spontaneous, periodic, and intermittent, while nerve tenderness is slight, absent or fleeting. Muscular atrophy, electrical changes, and areas of anæsthesia are not present.

In sciatic *neuritis* pain is constant, with no remission. Nerve tenderness is present, and in severe cases the Achilles jerk is lost, while muscular atrophy, anæsthesia, and trophic changes ensue.

Secondary sciatic pain is usually of neuralgic nature, and, unlike the primary types, is often not referred to the sciatic trunk, but to its area of distribution—viz., the outer side of the calf, and the external half of the dorsum of the foot. In secondary sciatica nerve tenderness is absent or slight in proportion to the pain. Straight leg extension (Lasegue's sign) does not—as in primary sciatica—infallibly increase the pain, which may, instead, be relieved by this manœuvre.

In **diagnosis** the most important point to decide is the primary or secondary nature of the affection. In this connection a routine rectal and vaginal examination to exclude intrapelvic growth is essential. The mobility of the hip-joint should always be investigated to exclude osteo-arthritis, the deep reflexes tested to obviate confusion with the lightning pains of tabes, and the urine should be examined for sugar.

Treatment.—Constitutional conditions should be met by suitable drugs.

When acute, the patient should be confined to bed, the leg placed in the position of greatest ease, and wrapped in wool. The leg may be at once straightened, if necessary using an anæsthetic. Salicylate of soda, aspirin, or morphin, are the best drugs to employ in acute pain. The injection of normal saline solution into the tissues or into the nerve itself has given good results. Baths and massage should be employed later. In chronic cases potassium iodide should always be

tried, as it must be remembered that sciatic pain may be symptomatic of locomotor ataxia.

In intractable cases the nerve may be stretched, under an anæsthetic, by bending the hip to a right angle, and then gradually extending the leg, or the nerve may be cut down upon, adhesions due to perineuritis separated, and the nerve extended. Needling is also sometimes employed, and consists in piercing the nerve at intervals with long steel needles, which should be left in for about twenty minutes. Absolute immobility in splints for several weeks sometimes gives good results.

Trigeminal Neuralgia.—An intense neuralgia which develops in one of the branches of the fifth nerve, and is associated with degeneration of the Gasserian ganglion.

At first the paroxysms take place at long intervals, but these gradually decrease. They are excited by some small accident, or even by such movements as opening the jaws, and the patient is worn out with apprehension even when free from pain. There is great tenderness at the points of exit of the different branches of the nerve.

Treatment.—Various drugs, as quinine, strychnine, arsenic, or gelsemine with butyl chloral hydrate (Benger's pill), may be tried, and the injection of 5 minims of osmic acid 1 per cent. solution into the nerve has sometimes relieved the condition by causing violent reaction.

Operative treatment consists in removal of the affected nerve by resection or avulsion. When this proves ineffective, and when branches of all three divisions are involved, the removal of the Gasserian ganglion gives good results, but the operation is a very serious and difficult one. It may be carried out by making an incision and opening the skull in the temporal region, after which the dura mater is stripped and the temporo-sphenoidal lobe raised to expose the ganglion (Krause-Hartley). Lately the injection of alcohol into the Gasserian ganglion has given good results.

Neuromata.—See Tumours, Chapter VIII.

CHAPTER XVIII

INJURIES TO THE HEAD

Diagnosis of cranial injuries—Cranial injuries: The scalp; wounds, contusions, hæmatoma, cephal-hæmatoma, cephal-hydrocele, treatment of scalp wounds, erysipelas—Cranial bones; contusions, fractures—Intracranial injuries; injuries to blood-vessels, injuries to the brain membranes, injuries to the brain (concussion, irritation, compression), traumatic epilepsy—Injuries to cranial nerves—Treatment of head injuries.

HEAD and spinal injuries owe much of their importance to the fact that the organs contained in the skull and the spinal column are of such vital import to life and health. Severe injury to the bony structure usually results in damage to the contained nerve tissue, though the brain or cord may be seriously damaged without the skull or spinal column being fractured.

Of all the injuries to which a patient is subject, probably none are fraught with such serious consequences as those to the nervous system.

The prognosis of such injuries is very uncertain, and he would indeed be a rash man who would definitely state it to one who has met with injury to brain or spinal cord.

The possible remote results are numerous and often obscure, so that a patient may come under observation at a date long after an accident suffering from some secondary effects of the injury, he having in the meantime enjoyed fair or good health.

It is beginning to be realized that many and curious conditions result from an injury to the nervous tissue, which formerly were treated, or untreated, as separate entities.

There is, of course, the other side of the question. Many cute persons, realizing that it is a very difficult matter to definitely state what injury is done by accident, especially to the spine, and how almost impossible it is to detect the malingerer, if he be a good actor, have made it their business to derive a permanent living out of trivial injury sustained by them, say in a railway accident.

It will be found convenient to consider first the diagnosis of cranial injuries in general.

DIAGNOSIS OF CRANIAL INJURIES.

The consideration of **contusions of the scalp** need not detain us, as they are not difficult of diagnosis. Erysipelas may ensue from improper or inefficient treatment, and endanger life.

There is, however, one form of **hæmatoma**—the **subaponeurotic**—which should be carefully diagnosed, as it may be confused with

depressed fracture of the skull. Its edges are hard and elevated, and its centre depressed, but the true nature of the condition may be diagnosed by passing the finger firmly from the surface of the uninjured scalp across the elevated edge, when it will be discovered that the latter is above the level of the skull, and can at times be pushed aside. The edges of the hæmatoma are also softer than the bone, and there is no sharp outline, as in a fracture.

Some confusion is at times caused by the presence of coma with a contusion of the scalp. If traumatic causation be eliminated, it may be taken that the coma results from some coincident constitutional cause, and that the contusion is merely coincident, or at most an exciting agent.

It should be remembered that after a fracture of the vertex in young people a hæmatoma may form, sometimes accompanied by signs of compression. If these be not present, care must be exercised that the case is not dismissed as one of contusion.

Fracture of the Skull.—It is not easy always to diagnose fracture of the skull, and it is well to pay attention to the following points and to answer the following questions :

What is the history of the injury ? What are the apparent results ? What is the meaning of certain signs and symptoms which may be present ?

The history will point, if a fracture be present, to some considerable force having been applied to a particular point of the vertex, or to a fall from a height on the feet or buttocks, or to a wound in an upward direction of the roof of orbit or mouth.

The apparent results of compound fracture will be an open wound leading down to the bone, which on examination will be found to have a fine opening, not in the line of a suture, through which blood may escape, or a depression which can be easily felt, or a puncture which will as a rule correspond with the shape and position of the scalp wound. There is no certain sign or symptom to indicate a simple undepressed fracture.

One or both tables may be fractured. It is difficult to diagnose definitely that only the outer one is fractured. It is more likely to occur in regions where there is a considerable space between the two, as over the frontal bone or mastoid process, and it can, of course, be demonstrated by chipping away the outer table. No intracranial symptoms exist unless where the force causing the fracture has also produced concussion.

When the internal table only is fractured, it is diagnosed by the **intracranial** symptoms.

When both tables are fractured there is depression, the fractured bone can be felt, and, if there be destruction of the bone, the pulsations of the brain may be distinguished.

The most **significant signs** of fracture of the skull are those which indicate fracture of the base. They are—

1. Escape of blood or cerebro-spinal fluid from the ears, nose, or mouth.
2. Presence of blood in the eyelids and under the conjunctiva, or in the region of the mastoid process.
3. Emphysema of the skin when the mastoid and frontal air-spaces have been opened.
4. Evidence of injury to the cranial nerves at the base of the skull.

In order to distinguish the particular fossa fractured, the following

table, taken from Eisendrath's "Surgical Diagnosis," will be found useful :

Fractures of anterior fossæ.	1. Subconjunctival and subcutaneous (eyelids) hæmorrhages. 2. Exophthalmos (due to retrobulbar hæmorrhage). 3. Bleeding or escape of cerebro-spinal fluid or brain substance from the nose or mouth. 4. Pulsating exophthalmos. 5. Anosmia (due to olfactory nerve injury).
Fractures of middle fossæ.	1. Subcutaneous hæmorrhages around the mastoid process. 2. Bleeding and escape of cerebro-spinal fluid or brain substance from the ear and mouth (per Eustachian tube). 3. Signs of injury of the second, third, fourth, fifth, sixth, and at times of the seventh, cranial nerves.
Fractures of posterior fossæ.	1. Subcutaneous hæmorrhages at upper part of back of neck. 2. Evidence of injury of the seventh to the twelfth nerves. 3. Bleeding from the ear.

The most **usual** symptom of fracture is loss of consciousness due to simple concussion, compression, or laceration of the brain substance. It must, however, be remembered that any or all of these conditions may be present without any fracture of the bones of the skull.

Concussion occurs, if at all, at the time of the accident, and may vary from a mere confusion of ideas and impressions or unconsciousness of a few moments' duration to a prolonged period of deep unconsciousness from which the patient never rallies.

The pulse is slow and weak, but if a fatal termination is drawing near it becomes quicker.

Breathing is slow and shallow, becoming more rapid if the patient is sinking.

The pupils are usually contracted, but may be dilated.

As the patient recovers, the pulse and respiration become stronger and more rapid.

There may be considerable irritation.

Vomiting often occurs.

Compression.—The symptoms of this condition differ according to the cause. If produced by depressed bone, they come on at once, and cannot always be dissociated from the symptoms of concussion and laceration. When due to hæmorrhage, symptoms of concussion come first, and may pass off, leaving the patient apparently well. In this lies a grave danger, as often the injured person, thinking he has recovered from the effects of the accident, goes about again ; this restarts the bleeding, which may have stopped, and unconsciousness is again produced. There may sometimes appear to be no bad results from the accident, no concussion having occurred, till symptoms of compression manifest themselves. On the other hand, concussion may verge into compression without the patient recovering consciousness.

The hæmorrhage usually comes from a branch of the middle meningeal artery, though it may arise from intracranial vessels or from the pia mater and arachnoid.

Compression is diagnosed from concussion by the history of the onset of symptoms, by the pulse being of high tension, breathing stertorous, and the pupils unequal, that on the injured side being dilated.

Symptoms of compression the result of accident have to be distinguished from those of coma arising from diabetes, uræmia, and apoplexy, from narcotic poisoning, and from the malingerer's feigned symptoms.

Laceration.—This is usually caused by direct violence from blunt instruments, bullets, or depressed fracture. The symptoms are present at once, but are usually masked by those of concussion or compression, and so the condition may not be differentiated till these have passed off. The pupils are unchanged as a rule ; the pulse is fairly normal, but feeble and rapid if the medulla be injured. This also holds true for respiration.

The main symptoms of laceration are those which point to injury of a particular area of the brain, and will therefore differ according to the site of injury. There are usually present twitchings or convulsions and some **particular** paralysis. These however, are, as stated above, usually masked at first by concussion.

The following diagnostic table shows the differences in the three conditions:

	Concussion.	Compression.	Laceration.
Appearance ..	Shock present	Present or absent	Present; recovery slow
Skin	Pale, cold, clammy	Variable	Pale and cold
Temperature ..	Subnormal	Variable (may be unequal)	Subnormal; rising later to 100° F.
Pulse	Weak and fluttering	Full and slow	Variable
Respiration ..	Slow and shallow	Stertorous	Variable
Mental state ..	Unconscious; variable degree	Deepening coma following a lucid interval in 50 per cent. of cases	Unconscious ; recovering slowly
Irritability ..	May come on later	Absent	Often marked
Convulsions ..	Absent	May be present	May be present
Rigidity	Absent	May be present	May be present
Focal signs ..	Absent	May be present	May be present
Pupils	Equal and contracted. In severe cases dilated; no reaction	Unequal and react differently to light	Unequal; react
Reflexes	Sluggish; in severe cases lost	Present	Usually present
Muscular system ..	Flaccid	Hemiplegia often present	Increasing paralysis if motor area affected
Sphincters ..	Not affected except in severe cases; then relaxed	Retention of urine	May be relaxed

Intracranial Suppuration.—Various forms of suppuration follow injuries, owing to infection of the meninges or the brain itself. Symptoms of the former usually appear within forty-eight hours of the injury, acute abscess of the brain within a week, while a chronic abscess may not manifest itself for years.

In acute suppuration following injury, cause and effect will be pretty apparent, but in the case of the chronic abscess the connection may not be easily traced. The possibility of this late sequela of injury to the brain should be clearly borne in mind, as a considerable proportion of all brain abscesses are traumatic in origin. The situation of the abscess usually bears a close relationship to the point of injury which is worth remembering in determining the causation of a chronic

cerebral abscess, though it may easily be that the patient can give little information as to the injured spot if the accident has occurred years previously.

Other late sequelæ of brain injury are traumatic or Jacksonian epilepsy, and certain mental conditions, as feeble-mindedness, irritability, and a predisposition to various mental diseases. The diagnosis of these conditions being due to an old head injury is not easy, and must depend largely on history.

When called upon to decide whether a case of Jacksonian epilepsy or mental disease is a remote result of fracture, or other severe injury to the skull, the following points should be considered :

What is the history of the case as to injury likely to have resulted in fracture, especially depressed fracture ?

Is there any deformity of the skull ?

Is there an old and painful scar ?

Is there paralysis of any cranial nerve ?

Cranial Nerves.—In fracture of the base of the skull certain nerves are frequently injured, especially the third, fourth, sixth, and seventh.

Injury to the motor oculi or third nerve causes external strabismus, ptosis, dilated pupil, and loss of accommodation.

Injury to the fourth nerve gives rise to diplopia and defective movements of the eye downwards and outwards.

Injury to the sixth nerve gives rise to internal strabismus and diplopia.

If the facial nerve (seventh) be injured, there will be paralysis of the muscles of expression on the injured side, which is best tested for by pressure on the supra-orbital nerves.

Other cranial nerves may be injured, and if so there will be paralysis of the parts served by their fibres.

CRANIAL INJURIES.

The Scalp.

Wounds.—These are made by sharp or blunt instruments. On account of the tightness of the skin over the cranium, one may be as clean-cut as the other. Such wounds are, of course, very common, but do not often lead to serious trouble if sepsis is avoided, since, even if the cellular layer between the pericranium and the aponeurosis be opened up and infected, prompt treatment prevents bad results. Should, however, a septic condition be set up in this region, and not efficiently treated, bad—even fatal—results may accrue, owing to the ease with which infection may spread along the veins to the meninges and cranial sinuses.

The exceptionally good blood-supply of the scalp renders certain rapid and sound healing even after extensive injury.

Injury to the scalp by means of a blunt object may produce a **contusion** without breaking the surface ; this may be superficial, subaponeurotic, or subpericranial. Under simple treatment the condition clears up rapidly.

Hæmatoma of the Scalp.—This occurs when vessels which have been lacerated bleed into the **subaponeurotic space.** Here the connective tissue is very lax, and the effusion may be a large one, which gravitates

to the zygoma, occiput, or eyebrows, according to the position in which the patient is placed. As pointed out already, the condition has to be diagnosed from depressed fracture. Hæmatomata are usually absorbed; the process may be hastened by pressure. At times absorption ceases short of the point of complete removal of the blood, when a **blood-cyst** remains. This consists of a connective-tissue capsule filled with a yellowish-red semifluid material—the remnant of the effused blood. It should be removed.

Cephalhæmatoma.—This is the name applied to a collection of blood between the **pericranium** and the **bone.** It is usually seen in the newly-born as a result of pressure during delivery, and is then situated over the parietal bone, and its extension limited by the attachment of the periosteum at the sutures.

Traumatic Cephalhydrocele.—Is the name given to a localized swelling, partly reducible by pressure, which occurs as the result of simple fracture in young children, when, owing to laceration of the brain membranes, the cerebro-spinal fluid of the subarachnoid space, and perhaps of the lateral ventricle, escapes through the opening of the skull and bulges beneath the scalp. Fits and mental deficiency often result. The cyst should be tapped or its neck tied.

Treatment of Scalp Wounds.—Shave the hair over an area round the wound, and treat the part in the routine way. When the dirt is ingrained into the margins of the wound, as frequently occurs, the edges should be cut away. Most perfect asepsis should be procured, all undermined portions of the scalp being opened up and drained. It is sometimes necessary, in order to effect this, to make counter-openings.

It is sometimes difficult to control bleeding of the scalp. If the vessels cannot be caught by artery forceps, or, on account of the large number of communicating vessels, when caught the hæmorrhage is not stopped, a catgut thread should be passed by means of a needle through the tissues around the bleeding-points, drawn tight, and tied. This as a rule checks the most persistent bleeding.

Except in small wounds and when asepsis is assured, drainage should be provided.

When infection of the wound takes place, it is evidenced by pain and heat, swelling of the tissues, which causes tension of the stitches, the œdema sometimes spreading to the eyelids and face. The treatment should then be **prompt,** and consists in removing the stitches, purifying the wound, and packing with iodoform gauze, the whole surface being covered with a moist anti-septic dressing. If effective treatment is not carried out, cellulitis, osteomyelitis, meningitis, and involvement of the intracranial venous sinuses, will probably result, especially when septic infection involves the subaponeurotic area or the pericranium.

Erysipelas often follows even microscopic wounds of the scalp, or is secondary to suppuration of the **frontal sinuses** or nasal fossæ. It is usually limited by the deep fascial attachment, and does not extend to the cheek or neck. Cellulitis may follow, and symptoms of cerebral and meningeal complications. Treatment follows general principles.

Cranial Bones.

Contusions.—No injury to the skull should be regarded lightly, on account of the importance and delicate nature of the contained organ. Patients who have received blows upon the head must be carefully

examined, and on no account should a hasty prognosis be given. The question of diagnosis does not enter much into the opinion of the result of contusion to the cranial bones, for there may be little or nothing to go upon, there being often neither wound nor severe bruise to indicate the harm done. It is largely a matter of hearing the patient's account of the accident, inquiring into the personal history, and saying as little as possible. Here, perhaps, in a very special manner is the resistant power of the individual of moment. If it be low, some inflammatory disease of bone, as acute osteomyelitis, may be set up; and if there be tuberculous or syphilitic taint, the injury may cause the disease to manifest itself. Apart from disease of the bone itself, contusion of the cranium may cause intracranial trouble. Thus, a subcranial abscess is sometimes formed; meningeal hæmorrhage may occur, or some late pathological cerebral condition be produced.

Fractures of the Skull.—Fracture of the cranial bones may be, like others, simple or compound; owing to the skull being hollow, they

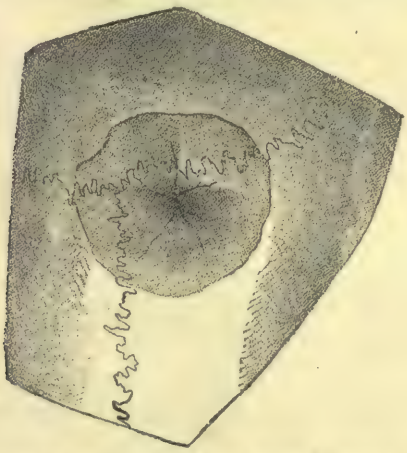


FIG. 43.—FRACTURE OF OUTER TABLE FROM IMPACT OF A HAMMER.
(Sluss, "Emergency Surgery.")

are further divided into **fissured** and **depressed** fractures, and, as a subdivision of the latter, **punctured** fractures. The fracture may be on the vault or at the base of the skull, the latter being usually of the fissured variety.

Fissured Fracture.—Is due to violence, direct or indirect, applied externally. This is a common form of injury in great industrial centres, where the accident may occur owing to some heavy article falling on the head or to the workman falling from a height, though the depressed variety is the more common after the latter accident.

It must be remembered that the cracking of the compressed bone is not limited to the point of application of the force, but may radiate to a considerable distance and involve more important parts than the one apparently injured, which explains certain symptoms which occur and do not seem warranted by the position of the fracture.

Even when compound, if there be no complications, a fissured fracture of the skull does not as a rule lead to any bad consequences, and the prognosis is good so long as all septic conditions are excluded.

Should, however, any excessive amount of callus form on the inner side of the skull in the process of healing, epilepsy and certain forms of mental weakness may be a late result of an ordinary fissured fracture, so that even in such a comparatively simple condition the surgeon should be guarded in his prognosis.

Depressed Fractures.—These are met with almost entirely on the vault of the skull, and are due almost invariably to direct violence applied by means of a fall or blow. The fracture may be simple or compound, frequently the latter, and is usually comminuted. Both tables are generally fractured, except in the case of young people. The table most damaged is that to which the violence is last applied.

Concussion and **compression** are associated with simple depressed fracture, the latter being due to the depressed bone and to exudation of blood. Prompt measures relieve the symptoms ; if unrelieved, a fatal termination usually results. In cases of slight depression the symptoms may not be severe at the time, but unfortunate sequelæ, as epilepsy, sometimes occur. This is probably due to the symptoms

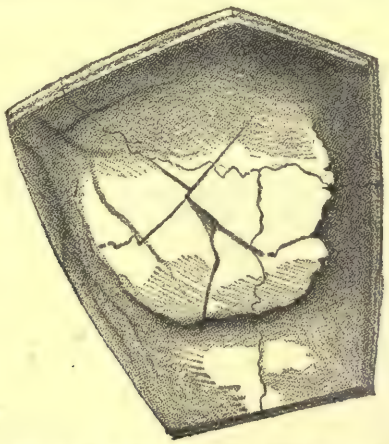


FIG. 44.—FRACTURE OF INNER TABLE.
(Sluss, " Emergency Surgery.")

not having been severe enough to induce efficient treatment at the time of the injury.

When a depressed fracture is compound, the symptoms are often not so severe as in simple fracture owing to the shattering of the bone and its coverings having used up the energy of the force, the brain thus escaping. Of course, if the force have been excessive, concussion and compression will take place. The great danger of a compound fracture, here as elsewhere, is sepsis, and, owing to the great importance of the tissue involved, it gives rise to grave fears when it occurs.

The **Prognosis** will depend on the nature and extent of the force, the amount of injury done, and the efficiency of the treatment. The last is the most important of all, since a great force may produce extensive damage which yet leads to no bad results owing to early and sufficient treatment; while, on the contrary, a comparatively simple injury may lead to endless trouble, remote consequences, and danger to life, becaues the treatment has been delayed. In all brain injuries a good deal will depend on the personal qualities of the patient

as to recuperative power and ability to resist adverse influences on the nervous system.

Fractures of the Base.—These result from extension of the fissure caused by fracture of the vault, or may occur after force has been applied to the vault without producing fracture there, owing to the giving way of the weakest part after compression of the skull. They also occur by direct injury to the base, when the fracture is often depressed, and by falls upon the vertex into soft material, or by alighting on the feet or buttock from a height. Such fractures may be transverse or longitudinal, the latter usually involving more than one fossa.

Fractures of the base are rendered **compound** in an unusual manner, and are liable to be overlooked. Thus, if the anterior fossa be fractured, the cribriform plate and the mucous membrane of the base are ruptured, and an opening to the air thus established. Should the middle fossa be involved, the naso-pharynx or tympanic cavity is opened, and a fracture of the posterior fossa may also open up the naso-pharynx. A fracture of the base by direct violence is usually compound, and that in the ordinary way by a penetrating wound from without.

Fracture of the base is rendered serious on account of the great importance of the structures liable to be injured, and is grave according to the extent of such injury. Modern methods have rendered the **Prognosis** much more favourable than it formerly was. **Serious sequelæ** are—the late consequences of injury sustained by brain, nerves, or bloodvessels, and the possible inclusion of the latter two structures in a callus.

Intracranial Injuries.

In fracture or other injury to the bones of the skull there is frequently coincident injury to the brain, and the vessels and nerves connected with it. It is these injuries, as has been stated, which make the accident to the skull a matter of so much and often grave importance.

The **Bloodvessels** are very frequently injured by the fracturing of the bone, and sometimes without such fracture.

The **Venous Sinuses,** especially the superior longitudinal, are frequently torn across, owing to the close connection with the bones. Even when the bleeding from a sinus is not severe, it may cause symptoms of compression if the wound is not sufficiently small to be closed by pressure against the bone. If the inner wall of the sinus be opened, the hæmorrhage will be considerable, and the blood, finding its way between the meninges, gives rise to symptoms of intrameningeal hæmorrhage. Sepsis and entrance of air are the main dangers.

The **Middle Meningeal Artery** is frequently ruptured both by concussion and fracture. The situation is usually at the anterior inferior angle of the parietal bone, corresponding to the situation of the anterior branch (95 per cent.). Very often the symptoms of hæmorrhage are masked by those of concussion; when these pass off the bleeding may have stopped, and the patient, getting up and walking away, or even restarting his work, presently falls down again unconscious, owing to the bleeding having restarted. The prognosis is not good.

The **Internal Carotid** may occasionally be injured by means of a wound. If the vessel be torn across, the result is fatal; if a partial wound be made, it often gives rise to pulsating exophthalmos.

Hæmorrhage may arise from the **Cortex of the Brain** itself or from the membranes with or without fracture; the blood may or may not be absorbed, and sometimes forms an arachnoid cyst. The hæmorrhage gives rise to pressure symptoms, and the patient usually passes from the condition of concussion to that of compression without a conscious interval. Recovery is the rule.

Hæmorrhage may also follow severe **Laceration of Brain Substance,** death usually resulting from the direct effects of the injury.

The **Diagnosis** of bleeding within the cranium is not as a rule very difficult. Even when there is not an open wound, the history of the injury, examination of the part, and sudden onset of symptoms, are guides to the probable trouble.

Injury to the Membranes of the Brain.—Inflammation of the lining membranes of the brain often follows an injury. It is usually quite impossible to distinguish the various forms clinically. As the result of a blow, with or without fracture of the bone, **Subcranial Abscess** or **Pachymeningitis** may result. The former will give all the symptoms of suppuration, together with those of intracranial pressure due to the pus pressing the detached dura mater upon the brain; while if there be an open wound, a puffy tumour will probably develop over the site of the abscess. The latter condition will give the symptoms of chronic meningitis after an interval during which no symptoms may occur.

If an infective wound be received, **Acute Diffuse Meningitis** will probably result after an interval of about forty-eight hours. The superficial part of the brain is generally involved in this condition. The **Symptoms** are severe and increasing headache, a very full pulse, irritability of the brain, giving rise to vomiting, intolerance of light, delirium, and twitching of muscles. A fatal termination often results from pressure on the brain. When the injury is a penetrating wound and the brain substance is involved in the abscess formation, the term **meningo-encephalitis** is employed. Frequently epileptiform seizures are a late result.

After injury to the meninges, and when recovery has apparently taken place, **Meningitis** may occur; this may be **Subacute,** the symptoms being similar, but milder in character, to those of acute meningitis; or **Chronic,** especially in syphilitic subjects. The former, owing probably to the condition the patient is usually in, is more likely to have a fatal termination.

Most of the above conditions are probably due to infective micro-organisms gaining entrance through an open wound or by penetrating through bone, which is lowered in vitality by the injury, to the area primarily affected.

Injuries to the Brain.—The results to the brain itself from falls or blows with or without fracture are very various.

There may be a simple stunning or **Concussion.** This is a condition of shock arising as the result of stimulation of the restiform bodies by a wave of cerebro-spinal fluid driven by the blow on the vault towards the base, producing anæmia of the brain (Duret). In many cases there are found small petechial hæmorrhages throughout the brain substance. As a rule there is a quiet unconsciousness, which may be of short or long duration. The concussion may produce such deep unconsciousness that the reflexes are abolished and involuntary evacuations take place, while the surface of the body does not react

to electrical stimulus. This unconsciousness may have various terminations; it may pass into deeper unconsciousness and death, or the patient may arouse to show symptoms of brain irritation, passing from that condition into the unconsciousness of compression. If a favourable termination is being reached, there will be reaction, shown by increased rate of pulse and respiration, turning on the side and pulling the bedclothes up on account of chill, and presently complete return to consciousness will occur. It is not usual for any sequelæ to follow simple concussion, but various mental disabilities may occur, such as loss of memory, or general neurasthenia.

The condition of **Cerebral Irritation** which may result from concussion is evidenced by mental and physical irritation. The patient usually lies upon his side curled up in the bed, and is very angry if any attempt is made to rouse him. The pupils are contracted, and, though excreta may be passed from the rectum, the bladder usually has to be emptied. As time passes, the irritability gives place to childishness, and gradual recovery usually takes place, leaving behind, however, liability to bad after-effects, the mind sometimes becoming seriously defective. This condition is due to laceration of the brain having taken place to a slight extent at the time of the accident, leading to small hæmorrhages into the brain substance.

When, owing to the presence of depressed bone, extravasated blood, spreading œdema, a collection of inflammatory exudation or pus, there is intracranial pressure, the condition of **Compression of the Brain** is produced. The brain is unable to perform its proper functions, and symptoms of coma arise. The patient lies on his back perfectly unconscious, and cannot be roused, thus differing from the lesser form of concussion and from irritation. Respiration is slow and stertorous, the pulse full and slow, the pupils are dilated, but vary in size according to the degree and position of the compression. In the later stages respiration and pulse increase in frequency, and paralysis, which at first is partial, becomes complete. The symptoms will, of course, differ according to the area of the brain compressed. The condition has to be distinguished from the coma, due to uræmia, diabetes, apoplexy, heatstroke, or narcotic poisoning. With regard to the latter, it must be remembered that a drunken person may sustain a fractured skull with compression, or alcohol may have been given after the accident, and thus the case present confusing symptoms. A most careful examination is always required when a person is found in a state of coma, with no history obtainable how he came by the accident. Often an immediate diagnosis is quite impossible.

Differential Diagnosis.—Coma of *Uræmia* and *Diabetes:* No real paralysis or stertor; urine contains albumin and sugar; œdema of lower limbs.

Coma of *Epilepsy:* History of the patient.

Coma of *Apoplexy:* No history of accident.

Narcotic Poisoning.—(*a*) *Alcohol:* Patient not deeply unconscious or paralyzed; pupils react; temperature subnormal; smell of alcohol from breath and stomach contents. (*b*) *Opium:* Smell of the drug; pin-point pupils.

Heatstroke: History; pupils usually normal; patient as a rule recovers quickly.

Malingerers can usually be detected with ease, as their condition is normal.

Non-penetrating and penetrating wounds of the brain give rise to

more or less severe **Laceration of the Brain.** Very slight laceration has been referred to under Irritation. Extensive laceration gives rise to very grave symptoms. Should the wound be open to the air, sepsis may occur, leading to disintegration of a considerable portion of brain substance. There may be deep abscess formation, and death may take place early from this or from spreading œdema. Should septic changes not take place, there may be a long delay before an abscess forms. If the part of the brain injured be an important one, paralysis and death will be an early result. If the area injured be small and unimportant, recovery may take place, the injured portion becoming absorbed.

One result of a septic wound of the brain sometimes seen is **Hernia Cerebri,** a protrusion of a portion of brain substance through the traumatic opening in the skull ; it is often fatal, but occasionally heals under suitable treatment.

Traumatic Epilepsy arises from unrelieved depression of the skull, excessive callus formation, and other conditions produced by an old head injury. Seizures are caused with or without aura, according to the portions of the cortex involved.

Similar causes may lead to **Traumatic Insanity,** which may, however, be relieved by operation.

These late sequelæ of brain injury should not be forgotten in their medico-legal aspect in dealing with head injuries.

Injuries to Cranial Nerves.

Many of the **Cranial Nerves** may be involved in fracture of the base or other injury of the skull ; as already pointed out, some are more liable to injury than others.

The **Olfactory Nerve** (first) may be injured by fracture through the cribriform plate of the ethmoid. The prominent symptom is the loss of the sense of smell.

In fracture involving the optic foramen the **Optic Nerve** (second) will be injured, leading to optic neuritis and partial or complete blindness. Should the nerve be ruptured, sudden complete and permanent blindness will take place.

The **Motor Oculi** (third) may be injured by trauma to the orbit, sphenoidal fissure, or base of the skull, giving rise to paralysis of the upper eyelid ; the recti muscles, producing external strabismus ; and the inferior oblique, producing a downward direction of the eye. There is also dilation of the pupil from loss of power of the iris, lack of accommodation owing to paralysis of the ciliary muscle, and at times protrusion of the eyeball owing to general relaxation of the muscles.

The **Pathetic Nerve** (fourth) is not often injured ; if it be, there is diplopia and paralysis of the superior oblique muscle, producing defective movements of the eye downwards and outwards.

The **Trigeminal Nerve** (fifth).—One or more divisions of the nerve may be injured, giving rise to loss of sensation in the parts supplied. Corneal ulceration may result when the ophthalmic division is injured; and paralysis of the uvula and soft palate, leading to a difficulty in swallowing, will result from injury to the great and small superficial petrosal nerves in fractures crossing the apex of the petrous portion of the temporal bone. Fractures of the base are the most common injuries which involve the fifth nerve.

The **Abducent Nerve** (sixth) is injured by penetrating wounds or blows involving the cavernous sinus, the sphenoidal fissure, or the orbit ; if divided, paralysis of the external rectus gives rise to internal strabismus. Diplopia is also present.

The **Facial Nerve** (seventh) may be injured in fracture of the petrous portion of the temporal bone, resulting in immediate paralysis, or—the common event—subsequent paralysis owing to inclusion in the callus. The facial nerve being that which supplies the muscles of expression, its injury leads to a loss of expression on the injured side, and when the patient tries to use those muscles the face is drawn **towards** that side, producing a characteristic and peculiar appearance.

The **Auditory Nerve** (eighth), if involved in fracture of the base, gives rise to deafness, which may be complete and bilateral, since both sides are often affected.

Injury to the **Glosso-pharyngeal Nerve** (ninth) will give rise to difficulty in swallowing, and possibly in speaking.

If the jugular foramen be involved in a fracture of the base, the **Pneumogastric** (tenth) and **Spinal Accessory Nerves** (eleventh) may be involved. If the former be injured, violent palpitation with vomiting and a sense of suffocation will result ; possibly a fatal termination may occur. Paralysis of the sterno-mastoid and trapezius muscles will result from division of the spinal accessory.

The **Hypoglossal Nerve** (twelfth) is seldom injured in head injuries ; if it be, one-sided paralysis of the tongue results.

Cervical Sympathetic.—The cord and ganglia in the cervical region may be injured by stabs and gunshot wounds, and also by operation wounds. When paralyzed by injury, the pupil is contracted on the affected side, nor does it dilate when in shadow. The palpebral fissure is also smaller than the other, and the eyeball sinks into the orbit. The neck and upper extremity of the affected side lose the function of sweating.

"Railway brain" and "railway spine" will be considered later under Traumatic Neuroses.

Treatment of Head Injuries.

For **Concussion** and **Irritation** the treatment is practically identical. The patient should be put to bed in a darkened, quiet room, with the head lowered. Cold in the form of an icebag or Leiter's tubes is useful in cases where there is probably some hæmorrhage. Bleeding and the application of leeches is successful in some cases. Atropin and ergotin in small doses have been recommended. As a purge, calomel or croton-oil should be employed. As the patient recovers, the head should be raised to avoid congestion and bleeding from some possibly damaged artery. The patient should be confined to bed for about a fortnight even after a concussion which has only produced a brief period of insensibility.

The general treatment for **Compression** is carried out on the same lines, but in addition the cause producing the condition must be removed. Thus, depressed bone should be elevated, a foreign body removed, and accumulation of pus or blood liberated.

When the **Middle Meningeal Artery** is ruptured by the accident which causes concussion or compression, it is usually evidenced by vomiting and severe headache some hours after the accident, and

frequently at the close of a lucid interval. Occasionally middle meningeal hæmorrhage does not occur till some time after the accident. This variety is called **Traumatic Apoplexy.** Immediate operation is called for, and has for its object the arrest of bleeding, removal of blood-clot, and the prevention of œdema of the brain. If a fracture is present, it is enlarged; otherwise the trephine is applied over the point indicated by the symptoms of paralysis, or, if these are not marked, over the anterior inferior angle of the parietal bone. The artery is often difficult to control, and may require plugging with a small wooden peg or antiseptic wax. Occasionally it will be necessary to ligature the external carotid artery.

When the **Internal Carotid** is torn or injured by a fracture of the base or a penetrating wound, ligature of the artery in the neck or of the common carotid is the only treatment. The accident is usually fatal.

When the **Venous Sinuses** are torn, the bleeding frequently stops spontaneously, as the pressure is low. Sometimes pressure symptoms call for trephining. If the wound is open, bleeding may be stopped by pressure or by forceps, which may be left on for forty-eight hours.

The treatment of **Fractures of the Skull** often resolves itself into the treatment of the accompanying brain conditions or injuries to blood-vessels, as already outlined, but it will be well now to mention the treatment required for the different forms of bone lesion met with in the skull.

When the fracture is a simple **Fissured** one, it is seldom diagnosed, and for itself requires no treatment. If compound or complicated by intracranial symptoms, treatment is carried out as already indicated.

A **Punctured Fracture** is compound, and so the outer wound must be purified, the piece of bone implicated removed, and the membranes or the brain beneath rendered aseptic.

Depressed Fractures when compound should be treated by elevating the depressed bone and removing comminuted fragments which are unconnected to pericranium or dura mater, and purifying the open wound. This should be done whether the depressed bone has given rise to cerebral symptoms or not. When the depressed fracture is a simple one, it is wiser to trephine and elevate the bone, even if there are no symptoms of pressure, to obviate the possible late results of persistent headache, traumatic epilepsy, and insanity. Some surgeons, mostly other than British, hold that the possible risk does not warrant the operation. In young children a considerable amount of depression rights itself, so that in their case, unless the fracture is compound or cerebral symptoms are urgent, operative treatment is not called for.

The general treatment of **Fracture of the Base** will proceed on the lines already indicated for all head injuries. When there are marked symptoms of compression, relief may be obtained by trephining the bone of the temporal fossa and opening the dura mater, and allowing the escape of cerebro-spinal fluid and the serous effusion of traumatic œdema which often exists. Lumbar puncture has also been tried for the same purpose, but is a dangerous procedure in these cases. An important point is to prevent septic infection, which often occurs through the pharynx and nose. Spraying the cavities with antiseptics, such as peroxide of hydrogen, is the best procedure. When the meatus of the ear is implicated in fracture of the middle fossa, it

should be cleansed and plugged with gauze, which is frequently changed when the discharge of blood or cerebro-spinal fluid is persistent. When compound fracture of the anterior fossa occurs by perforation of the orbit, the frontal bone should be trephined in order that the fragments of bone may be removed and drainage provided.

The treatment of **Hernia Cerebri** consists in removing, if possible, the cause of increased intracranial tension. Icebags may be applied to reduce the tumour. The size of the opening in the skull may sometimes be increased with benefit, in order to allow of more brain matter protruding, and so reducing pressure. If sloughing or pedunculated, the hernia may be sliced off; otherwise it may be painted with formalin solution. As the condition is frequently caused by a compound fracture having become septic, asepsis should be achieved, and later, when the hernia has been dealt with, bone may be transplanted or an artificial plate used to close the skull.

Traumatic Epilepsy may be treated by bromides as a palliative measure, but operation is indicated where the symptoms point to a particular part of the brain being implicated, with a view to removing the cause, such as depressed or thickened bone, adherent membrane, cysts, or a sclerosed portion of the cortex.

CHAPTER XIX

SURGICAL DISEASES OF THE HEAD

Diseases of the scalp: Abscess, eczema, syphilis, lupus, tumours and cysts—Diseases of cranial bones: Periostitis, osteomyelitis, mastoiditis, tuberculous and syphilitic disease, tumours—Diseases of cranial contents: Meningitis, cerebral and cerebellar abscesses, phlebitis of sinuses, cerebral tumours, affections of cranial nerves, cranio-cerebral topography.

DISEASES OF THE SCALP.

Infective Abscess Formation.—Occurs in the subcutaneous cellular tissue of children of poor physique. It is frequently associated with impetigo, eczema, or pediculi, and is probably due to tuberculous or pyogenic infection, or both combined. Such abscesses should be opened and dressed. An abscess in the scalp may also be secondary to disease of the cranial bones.

Eczema of the head is of importance in that it may lead to infection of the lymphatic glands.

Syphilis may affect the scalp in the form of gummata or eruptions.

Lupus may occur subsequent to the disease being present in the face.

Tumours and Cysts.—Adenomata originate from the sebaceous or sweat glands. They may be the seat of suppuration or epithelioma. The tumours should be excised when recognized. They occur as glistening swellings covered with very thin skin of a purple colour. The growth may be multiple. The so-called **tomato tumour** of the scalp is an adenoma of the sweat glands.

Papillomata (warts) may occur, and should be removed by snipping off with scissors, as they may serve, if irritated, as a starting-ground for epithelioma.

Neuroma of the fifth nerve occurs, and may assume large proportions.

Rodent Ulcer occurs usually as an extension from the face.

Epithelioma, as pointed out, may spring from papillomata or adenomata.

Sarcoma occurs as a secondary affection to that of the cranial bones.

Air Tumours occur as swellings, without pulsation or fluctuation, beneath the pericranium after perforation of the mastoid or frontal air cells. They call for no treatment. When fracture of the skull involves any of the sinuses, a peculiar crepitation is given on palpation, due to air being present in the cellular tissue between the pericranium and the aponeurosis (**emphysema of the scalp**).

Nævi occur on the scalp, and sometimes over the fontanelle, when pulsation is transmitted to them from the brain ; in this case they have to be diagnosed from a meningocele. Treatment follows general lines.

Cirsoid Aneurism is met with in connection with the temporal artery. Large bluish vessels are seen, having a pulsation synchronous with the heart. The condition gives rise to headache and dizziness, and, if ulceration should occur, to most serious hæmorrhage.

The best treatment for a pronounced case is excision after ligature of the main vessels entering the tumour. Multiple ligature of the dilated vessels and electrolysis have both been tried with success.

Traumatic Aneurism resulting from "bleeding" the temporal artery is now scarcely ever seen, but **Arterio-Venous Aneurism** as a result of injury is met with, and is best treated by removal of the parts of the vessels affected.

Sebaceous Cysts, often called "wens," are a common affection of the scalp, though they are, of course, met with in other situations. This is one of the group of retention cysts, and forms in connection with the sebaceous glands and hair follicles. They are frequently multiple, and the affection appears to run in families. They are smooth, rounded swellings, firm and elastic, and contain epithelial cells, at first dry, but quickly breaking down, probably owing to bacterial infection, to become a semifluid material having a peculiar odour.

The treatment is to remove the cyst wall and contents. If the former cannot be entirely removed, it is wise to destroy the remnant with pure carbolic acid.

Dermoids, chronic abscesses, and fatty tumours, may be mistaken for wens. Dermoids occur in earlier life, fatty tumours are lobulated and more movable, and abscess of the scalp is not common; but an exploratory puncture will settle the diagnosis when in doubt.

Dermoids of the scalp have usually one of three seats—anterior fontanelle, outer angle of the eye, or occipital protuberance. They may be connected with the dura mater, which should be remembered in their treatment.

Serous Cysts are sometimes met with in the occipital region. In origin they are probably meningoceles which have become cut off during fœtal life.

DISEASES OF CRANIAL BONES.

Periostitis and Osteomyelitis.—Usually of traumatic origin, but either may result from infection through the blood-stream, or follow suppurative middle-ear trouble when the mastoid process is affected, and cellulitis of the scalp.

Symptoms.—A rigor usually occurs, followed by high temperature, local pain, and tenderness. Soon a fluctuating swelling appears. When the pus forms between the bone and dura mater, the overlying portion of the scalp becomes œdematous; this is known as **Pott's puffy tumour.**

When the pus forms under the pericranium, it quickly produces necrosis unless early incision liberates the pus. The necrosis may involve the whole thickness of the skull or only the outer table. Serious intracranial complications may arise, which will be considered later.

Treatment consists of an early incision to release pus and admit of disinfection. If the pus has formed beneath the bone, the latter should be trephined. If necrosis of bone have taken place, it is sometimes well to hasten the separation of the sequestrum; and since new bone is not formed, the gap is of the whole thickness of the skull. It

may be filled up by an osteoplastic operation, removing the scalp and outer table from a contiguous part of the skull and placing it on the denuded portion ; or it may be filled by a plate of various materials —bone, celluloid, silver, etc.

Suppuration in the Mastoid Antrum and Cells (Mastoiditis).—This usually occurs during the course of middle-ear disease, and is frequently secondary to influenza. The process extends so as to involve the cells, and sometimes the outer cortex of the mastoid, giving rise to squamo-mastoid abscess. The disease may also extend to the sigmoid sinus and the brain. The mastoid antrum should be drained or the complete mastoid operation performed.

Tuberculous Disease.—Usually met with in early life. It begins in the diploë ; a sequestrum is formed, around which the disease progresses. Granulations form on both sides of the skull bone. The sequestrum is gradually separated as a round piece of worm-eaten bone.

A tender swelling forms which gives a slight sense of fluctuation. As the pus spreads towards the surface, fluctuation increases, since the pus is not confined by the pericranium, and finally the skin becomes involved and the abscess bursts through one or more openings on to the surface.

The abscess should be opened before it bursts, and the sequestrum removed and granulating tissue scraped away.

Syphilitic Disease.—Occurs during the tertiary period, and affects as a rule the frontal and parietal bones. The infection reaches the point attacked by the blood-stream, but trauma is a frequent predisposing agent, and, as elsewhere and in other diseases, lowers the resisting power to the effects of the organisms. **Caries** is the resultant condition when sepsis exists, and **Necrosis** when the blood-supply is cut off by the gummatous tissue. Unlike tuberculous affection, the syphilitic disease may begin in the pericranium, diploë, or dura mater. As in other diseases, if the process extends intracranially, pressure on the brain will give rise to pain, epilepsy, or paralysis, and, if the nerves at the base are pressed upon, to pain and paralysis in the area of their distribution.

The treatment is that of local conditions, together with the treatment for tertiary syphilis.

Tumours.—**Osteomata** may attack the bones of the skull—not often the base.

Sarcoma may originate in the diploë, pericranium, or dura mater. It may grow outwards or inwards—usually the former—or in both directions at once. The disease may be mistaken for an abscess owing to the rapidity of the growth and to its forming a soft swelling which may have a faint fluctuation. There is sometimes pulsation, and on exploration the softened area of the bone is felt, and may be passed through by the examining finger. When practicable, the growth should be removed. When left alone, a fungating mass usually bursts through the skin.

DISEASES OF THE CRANIAL CONTENTS.

As already pointed out, many diseased conditions of the cranial contents are due directly or indirectly to trauma. It is, however, well to consider them under the present heading as diseases, and trauma

as a producing cause, together with similar and diverse conditions due to other causations.

Apart from traumatic origin, chronic middle-ear and mastoid suppurations are probably the commonest causes of those intracranial diseases which owe their origin to septic infection, usually by means of the *Staphylococcus aureus* and the *streptococcus*, though other organisms are met with.

The organisms make their way through the perforated *tegmen tympani* or sigmoid groove, or by the blood-stream by means of the emissary veins. The nasal cavity and air sinuses adjoining may become septic and give rise to pathological intracranial conditions. From the clinical standpoint, as has been already pointed out, it is frequently not possible to distinguish infection of one part of the cranial contents from another, and this for two reasons—because many of the symptoms are common to all, and because frequently infection of more than one part is present at the same time.

Meningitis.

Pachymeningitis.—An inflammation confined to the dura mater. It is usually secondary to disease of the bone. The external layer is thickened and covered with granulations, while there is effusion of fluid between it and the bone. This stage is accompanied by some degree of headache, but by no further symptom. Later on in most cases the space between the dura and the bone is the site of suppuration, which leads to the formation of an **extradural abscess.** This is accompanied by a sudden rise of temperature and shivering, together with severe pain referred to the site of the abscess. The bone above the abscess is inflamed, and the scalp becomes swollen and œdematous—a condition which is always indicative of extradural suppuration, and called **Pott's puffy tumour,** after the surgeon who first drew attention to the condition as an accompaniment of extradural abscess. The presence of symptoms of brain pressure will depend on the amount of pus formation.

Treatment.—When secondary to middle-ear trouble, the mastoid should be opened and a portion of bone removed to allow of drainage. When secondary to trouble in the frontal sinus, a trephine opening should be made in the frontal region, taking the puffy tumour of the scalp as an indication of position. When secondary to trauma, where there is a compound fracture, the wound should be enlarged, and loose or diseased portions of bone removed.

Leptomeningitis.—When the infection spreads from the dura to the arachno-pia, a local leptomeningitis is set up. This usually leads to the formation of adhesions and a cutting off of the infected area from the general arachno-pial space. As in the preceding conditions, pus may form, but here it is under the dura, forming a **subdural abscess.** The pressure is therefore greater upon the brain surface, and the cortex itself may be implicated, when the condition is known as **Meningo-Encephalitis.** The symptoms will be similar to those of the extradural abscess, but are more likely to be accompanied by those of pressure of the brain.

When adhesions do not form in time to cut off the septic process and make it local, there occurs a **General Leptomeningitis** from infection of the whole space of the arachno-pia. This may spread widely

over the surface of the hemispheres, and also involve the base. There is a large effusion of cerebro-spinal fluid into the space, and also into the ventricles, which soon becomes purulent. The membranes become thickened and the veins engorged, while the superficial layers of the grey matter may become involved in the process. This general purulent leptomeningitis will give rise to much more serious **Symptoms** than the localized condition. There is great pain in the head, referred to the frontal or temporal region; a quick rise of temperature without a preceding rigor; the pulse is weak but rapid; the vomiting which occurs has all the signs of cerebral as opposed to gastric disturbance —*i.e.*, **it is sudden, with no preceding nausea, is unassociated with the ingestion of food, and is not attended by violent retching effort.** If the cerebro-spinal fluid be withdrawn by lumbar puncture, the number of leucocytes is found to be increased, while pyogenic organisms are found, which is a point of differential diagnosis between the condition present and cerebral abscess. Paralysis may occur where there is marked inflammation over the cerebral hemispheres. If the base be much affected, there is often squinting of a temporary character, which is due to irregular movements of the ocular muscles; the pupils at first contracted, and later on dilated and fixed, retraction of the head, and very high temperature, are further points to be noted in basal meningitis. Intracranial tension symptoms increase, the pulse and respiration become weaker, unconsciousness gradually ensues, and death in three to four days is the usual ending of the condition.

Treatment.—Remove, if possible, the source of infection. When coming from a compound wound producing a subdural abscess, a good deal can be done by rendering the parts aseptic and by purifying and draining the meningeal space. Vaccine treatment and the removal of cerebro-spinal fluid by lumbar puncture are of benefit at times. These cases are, however, not hopeful ones to treat, and often nothing can be done beyond the relief of symptoms and the routine treatment of head diseases and injuries, such as purging, cold to the head, and occasionally, in suitable cases, cupping or bleeding by means of leeches.

Tuberculous Meningitis (Acute Hydrocephalus).—This form attacks chiefly the basal meninges. There is an excess of fluid both in the ventricles and in the arachno-pial spaces. It is almost invariably caused by the tubercle bacillus producing an acute tuberculosis, which attacks the membranes of the brain, though it is often secondary to an old tuberculous lesion of the bronchial or mesenteric glands. The condition is, of course, quite distinct from **chronic hydrocephalus,** which is a disease of early life or of congenital origin, and is often associated with rickets or syphilis (see Deformities, Chapter XIV.).

Symptoms.—Irritation, severe headache, photophobia with inequality of pupils, vomiting, convulsions, and cutaneous hyperæsthesia. **Kernig's sign** is usually present. This consists of pain on flexing the hip when the knee is extended, and inability to extend the knee when the patient is sitting. It is due to irritation causing strong contraction of the hamstring muscles. Later on there is paralysis of the ocular muscles, high temperature, rapid pulse, and respiration of the Cheyne-Stokes type. The cerebro-spinal fluid is found to contain an excess of mononuclear lymphocytes, and the tubercle bacillus may sometimes be demonstrated.

The surgical **Treatment** of tuberculous meningitis is lumbar puncture or drainage through the occipital fossa. The results on the whole have not been good.

Lumbar Puncture.—As it was in connection with tuberculosis of the meninges that Quincke first suggested lumbar puncture to relieve the intracranial pressure by withdrawal of cerebro-spinal fluid, the procedure will be described here.

Its use is now a fairly extended one for diagnostic and curative purposes, as well as to produce spinal anæsthesia. The space between the fourth and fifth lumbar vertebræ is selected as being the widest. With the patient lying on the left side and the knees drawn up to the chest, or seated with the knees drawn up and the body bent forward, the upper level of the fourth lumbar spine is indicated by drawing a horizontal line across the back at the level of the highest point of the iliac crests. Aseptic conditions having been produced, a needle is introduced in the middle line ½ inch below the fourth lumbar spine, and passed forwards and slightly upwards. When there is no abnormal tension, the cerebro-spinal fluid comes away drop by drop, but in certain pathological conditions where the tension is high the fluid comes in a stream.

Normal cerebro-spinal fluid is clear, without colour, of a specific gravity of 1004 to 1008, and contains serum globulin and albumose, together with a trace of chlorides. When examined under the microscope, a few lymphocytes and large endothelial cells are seen to be present .

Diagnostic Uses of Lumbar Puncture.

In Hæmorrhage : If extradural, no blood is found in cerebro-spinal fluid. If recent (due to puncture wound), after centrifuging, the top part of the fluid is clear ; if old (intracranial and spinal hæmorrhage), the fluid has a yellow tinge.

In Acute Meningitis : The fluid is turbid, owing to excess of albumin and presence of pus cells. Specific organisms are present according to the causation of the disease.

In Septic Condition : Polynuclear leucocytes are present.

In Tuberculous Meningitis : Presence of organisms, though difficult to find, and presence of polynuclear leucocytes.

In Syphilis : Mononuclear leucocytes are present.

In Malignant Tumours : Characteristic cells found in some cases.

In Uræmia : Diminished chlorides, increased phosphates and sulphates, present.

In Cerebro-Spinal Meningitis : The organism may be demonstrated.

Therapeutic Uses of Lumbar Puncture.

In Cerebral Tumour and Tuberculous Meningitis : To relieve headache, blindness, coma, and dizziness, caused by excessive quantity of fluid in the arachno-pial space, withdraw 30 to 40 c.c., but not more, since if the ventricles are emptied the pressure will bear directly on the basal ganglia.

In Basal Fracture : To relieve pain, delirium, and coma, remove a similar quantity. The fluid should be withdrawn slowly in all cases.

In Uræmia : Useful in certain cases to withdraw cerebro-spinal fluid.

For Anæsthesia : Useful in some cases to produce anæsthesia by injecting stovaine and other preparations (see Anæsthetics, Chapter V.).

In Tetanus : This route is sometimes chosen to inject antitoxin.

In Cerebro-Spinal Meningitis : Repeated puncture and injection of Flexner's serum.

Cerebro-Spinal Meningitis.—This form of disease of the meninges is usually met with in epidemics, but occasionally sporadically. It is caused by the *Diplococcus intracellularis*. The course of the disease is much the same as that of acute general leptomeningitis, and it is attended by the formation of sero-purulent exudation; this soon becomes fibrinous, and covers brain, cord, and membranes. If the foramen of Magendie become blocked, hydrocephalus will be set up. It is often difficult to distinguish the condition from other forms, especially when the disease occurs sporadically. With the object of settling the diagnosis, cerebro-spinal fluid is withdrawn by lumbar puncture and the organism demonstrated.

Treatment is not very satisfactory. In the early stages especially, repeated lumbar puncture and withdrawal of fluid has proved of benefit. The best results would appear to follow the injection of **Flexner's serum** into the spinal canal.

Abscess.

Cerebral Abscess.—The most usual position for cerebral abscess is the **temporo-sphenoidal lobe,** since the commonest causation is chronic disease of the middle ear, either by direct infection through the roof of the middle ear, or by means of the blood-stream. Occasionally infection may be carried by the route of the lymph spaces.

The abscess is usually single; the pus is yellow with a shade of green, or brown from broken-down blood-clot. The arachno-pial membrane over the abscess is usually of turbid appearance, while the brain substance around the abscess is inflamed and to some extent invaded by pus. If the abscess be chronic, there is often a definite capsule, formed of fibrous tissue, which surrounds and differentiates the pus, so that no symptoms are shown for a considerable period, perhaps several months.

Symptoms.—In a patient who is often the subject of middle-ear trouble, there is sudden intense pain radiating from the temporal region in various directions. The rise in temperature is usually preceded by a rigor. Cerebral vomiting occurs, **frequently on awakening in the morning,** and the tongue is very dirty. Optic neuritis develops, especially with more chronic cases. At the time these symptoms manifest themselves the discharge from the ear frequently abates. After a few days the patient becomes dull and stupid, and there is widespread tenderness in the mastoid region. The temperature falls to subnormal, the pulse and respiration rate fall, and there is disturbance of the intestinal tract. There is localized paralysis, varying according to the site of the abscess; there may be convulsions. If untreated, a cerebral abscess usually has a fatal termination, either by bursting into the ventricles, causing a sudden change for the worse in the symptoms, followed by speedy death, or by gradually increasing coma.

If the abscess be situated in the **parietal** lobe, there will be paralysis of the face and limbs on the other side of the body.

If in the **occipital** lobe, there is interference with sight.

If in the **frontal** lobe on the left side, and involving Broca's convolution, there will be motor aphasia.

Cerebellar Abscess.—Abscess in the cerebellum is fairly common, and is usually secondary to septic thrombosis of the **sigmoid sinus,** either

directly through the wall of the sinus from a subdural abscess or through the blood-stream.

Symptoms.—There is vertigo, inco-ordination of movements, retraction of head and neck, slow pulse, and subnormal temperature. The patient is sleepy and stupid, and speech is slow, the words being jerked out when they do come. On attempting to walk, the patient usually falls towards the same side as the lesion. If pressure is exerted on the medulla, there is one-sided or complete paralysis of the limbs. The respiration is liable to be interfered with, and may even stop for a brief period.

Treatment of Brain Abscess.—Having diagnosed the position of the abscess, a trephine opening is made—in the case of **temporo-sphenoidal (cerebral) abscess** ¾ inch above external auditory meatus, for **cerebellar abscess** 1½ inches behind and ½ inch below the exterior auditory meatus. If the abscess does not bulge into the trephine opening, the dura should be divided and pus sought for with a pair of forceps. On reaching the focus the forceps are expanded and pus liberated, after which the cavity may be gently washed out with sterilized water and a gauze drain inserted. Brain substance may be made diffluent and washed away!

Phlebitis of Sinuses.

Suppuration of the middle ear is the most common cause, though it may be due to other sources of intracranial infection, such as erysipelas of the face and scalp, septic conditions of nose and mouth, and those diseases of the bones of the skull which are infective. The mode of entrance may be direct through the bones or by extension of thrombosis.

The sinus becomes filled by soft blood-clot, which adheres to the side, and, since it is infected with pyogenic organisms, purulent disintegration quickly takes place. The process may spread backwards, giving rise to an abscess in the cerebrum or cerebellum, or to purulent meningitis. Portions of the infected clot may break away and form septic emboli. These may give rise to pulmonary infarctions and abscess.

Varieties—*Lateral Sinus.*—This is the most commonly affected, and usually from the ear.

Cavernous Sinus.—This is the next in order of frequency, and infection comes from nose, orbit, or face.

Longitudinal Sinus.—Infection of this sinus is not common. It comes from nose, face, or scalp.

Symptoms.—Sudden and severe headache, with marked tenderness over the affected sinus. Repeated cerebral vomiting. Repeated rigors. Oscillating temperature, running up to as high as 105° F., with initial rigor. Interference with respiration, accompanied by cyanosis, is marked during the rigors. The pulse is soft, full, and slow, but the rate increases with the rise of temperature.

When the **lateral sinus** is affected, there is a cessation of previously existing discharge from the ear, the internal jugular vein is tender, and perhaps there is swelling along its site; unilateral congestion of the face on the affected side occurs.

When the **cavernous sinus** is affected, there is congestion of the orbit and marked exophthalmos. Other eye symptoms due to pressure are—chemosis, choked disc, retinal hæmorrhages, ocular paralysis. Extension may take place across the pituitary sinuses.

When the **superior longitudinal sinus** is affected, there is œdema of the scalp and turgescence of vessels, epistaxis, and convulsion affecting one or both legs, which may be followed by paralysis.

Treatment.—Remove primary source of infection, if possible, as by a radical mastoid operation ; then extend this operation wound backwards, or trephine ¾ inch behind the external auditory meatus to expose the lateral sinus.

To prevent the extension of septic material, the internal jugular vein may be ligatured before the sinus is exposed. The sinus will probably feel tense, owing to the presence of thrombus ; this should be removed by opening the sinus, which is then purified and packed with iodoform gauze or worsted. Bleeding can usually be controlled by pressure.

For treatment of the superior longitudinal sinus the trephine should be applied above the torcula.

Operative treatment of the cavernous sinus is not practicable as a rule.

Cerebral Tumours.

Varieties—1. **Malignant.—Glioma :** This is a sarcoma composed chiefly of neuroglia. It forms a soft inflammatory growth which is very vascular and liable to cystic changes ; bleeding frequently takes place into the cysts. It is non-encapsulated, and therefore difficult to remove.

Other **Sarcomata :** Grow slowly and rather apart from the brain substance, which they do not destroy. They are therefore somewhat defined in outline, and more easily removed than glioma.

Secondary Carcinoma.—This is not a common form of brain tumour.

2. **Innocent.—Psammoma :** Springs from the choroid plexus.

Endothelioma : Grows from the meninges below the tentorium, or between the pons and cerebellum. They are favourable for removal, since they do not infiltrate.

Cysts.—Arachnoid cysts may occur from absorption of blood-clot following trauma. Simple cysts and hydatids sometimes occur.

Tuberculous Masses and Syphilitic Gummata.—These are amongst the most common tumours of the brain.

General Symptoms.—Headache in a fixed situation, which may become much worse suddenly, and the pain steadily increase. There may also be some tenderness over the region of the tumour. **Vomiting** having no relation to food, and not preceded by nausea, may occur on awaking in the morning ; this variety of von iting is of a jerking, almost involuntary, character. It is usually a marked symptom when the tumour is near the base. **Optic Neuritis** begins as a "congested," later becomes a " choked disc," and finally ends in atrophy. The eye on the tumour side is first and chiefly affected. This symptom is also marked in the basic growths. **Mental Symptoms**, as giddiness, loss of memory, epilepsy, together with stupor and coma, will vary according to the area affected. **Focal Symptoms**, when a motor area is affected by the tumour, will be localized convulsions and temporary local paralysis. Both symptoms may become widespread and permanent when tumours are situated in the cerebellum or pons. Paralysis of third, sixth, and seventh nerves occurs together with increased sensitiveness or loss of sensation in parts supplied by the trigeminal, and followed by deafness from involvement of the fifth and eighth nerves. When the tumour is in the **Pituitary Body,** acromegaly, loss

PLATE L.

ENDOTHELIOMA DERIVED FROM PIA MATER AND COMPRESSING THE CEREBRAL TISSUE.

(Museum, Queen's University of Belfast.)

[To face page 57.

of sexual functions, optic atrophy, and bilateral temporal hemianopsia, occur.

Prognosis.—Always grave if untreated. Sudden death may take place at any time from hæmorrhage, acute œdema, or the involvement of vital centres. The case may prove chronic in cystic and innocent growths. Most cases die within three years. It is seldom that a brain tumour of any kind is completely and permanently cured.

General Diagnosis.—Diagnosis of the precise kind of tumour present is very difficult, if not impossible. There are, however, certain points that may guide one in making a diagnosis :

In **Syphilitic Gumma** there is usually an ascertainable history of syphilis. The condition manifests itself in the fifth and sixth decades. Nocturnal pain of a severe nature is a pronounced symptom. The growth is rapid, and is superficial and easily enucleated. Improvement often follows the administration of the iodides, mercury, and arsenic, though in some cases little or no improvement results.

Tuberculous Growths occur usually in young people, secondary to disease in other parts of the body, physical signs of which, however, may not be present. Irregular growth and involvement of the base, with symptoms of meningitis, are characteristic of the condition.

Glioma : Usually present in early life. Growth is at first slow, then rapid. Sudden hæmorrhage into the brain substance causes grave aggravation of symptoms.

Sarcoma occurs from puberty to middle life. Growth is slow, producing pressure rather than destruction of brain tissue. The tumour is more or less defined.

Treatment.—The iodides should be tried, as the symptoms are frequently due to syphilis ; and even when this is not the case, benefit would appear to follow their use—at least for the time being.

Operative treatment may be carried out to cure or to palliate symptoms. In the former case success may be hoped for if the tumour is not deeply seated, is more or less differentiated or encapsuled, and is not of great size. The brain may be exposed by a trephine opening, and, if necessary, subsequent enlargement made by gouge or bone forceps, or by the osteoplastic method. The dura is opened by making a flap, or crucially, and the tumour sought for and removed. To avoid hæmorrhage, all vessels of the pia over the area of the brain to be cut should be ligatured in two places before division.

Cysts and tuberculous masses are usually near the surface, and can be shelled out without any cutting of the brain substance.

Sometimes the operation is done in two stages, the brain being explored on the second occasion. This lessens shock, but the procedure is not as a rule to be recommended.

Palliative operative interference consists of removing the bone over the tumour, and thus relieving the symptoms—severe pain and vomiting—and preventing blindness (**decompression operation**). For cerebral tumours a subtemporal operation, and for cerebellar tumours a suboccipital operation, is advised. The external wound is subsequently closed.

Repeated lumbar puncture has been of use in some cases in relieving intracranial pressure.

Affections of Cranial Nerves.

The effects of injury to the cranial nerves producing symptoms of irritation or paralysis have already been considered. These symptoms may, however, be produced by other than traumatic causes. Thus, the pressure of tumours or inflammatory exudations, and the effects of meningitis, may set up various symptoms referable to the nerve implicated, which will not differ for the most part from those produced by trauma. When a nerve is merely contused or pressed upon by inflammatory exudate or blood-clot, the paralysis will probably be of a temporary nature; but when it is severed or pressed upon by a new growth, the paralysis is permanent. It is noticeable that after some injuries the resulting paralysis does not come on for several days: it is then due to (*a*) gradual pressure from an increasing blood-clot, (*b*) septic meningitis, or (*c*) ascending neuritis. If it be the trunk of a nerve that is affected, the paralysis will be on the same side; if the cortical centres be concerned, the paralysis will be on the other side.

What has been said under Injuries will suffice for the symptoms seen in most cases when the cranial nerves are affected by non-traumatic sources of irritation or pressure. More detail must, however, be given concerning paralysis of the facial nerves.

Bell's Paralysis (complete unilateral facial paralysis) is most commonly produced by suppuration in the middle ear. The nerve may be pressed upon by inflammatory exudate in the aqueductus Fallopii, or it may be destroyed by the inflammatory process, particularly where the bony wall of the aqueduct is thin, as in young children. The nerve may also become involved in tuberculous and malignant conditions of the middle ear. Long exposure to cold and trauma are other sources of this paralysis.

Symptoms.—The affected side of the face has no expression, chiefly because all wrinkles and folds are obliterated. When the patient speaks, and more especially if he attempt to laugh, the condition is characteristic and remarkable, the face being drawn to the **sound** side. The eye, when the patient tries to close it on the affected side, rolls upwards and outwards, the conjunctiva becomes dry and irritated, and tears run over on to the cheeks. If the patient be asked to whistle, he makes a ludicrous attempt, but is unable to make any sound, owing to paralysis of the buccinator muscle. Food collects between the gums and the cheek. There is also paralysis of the orbicularis oris muscle, the patient being unable to bare his upper teeth. Care must be taken not to overlook the condition when both sides are affected, since the symptoms given above are, of course, not noticeable.

Treatment.—Remove the cause when possible, and treat the paralysis present by such drugs as iodide of potassium, iron, and strychnine internally; by blisters, or by massage and electrical treatment locally.

CRANIO-CEREBRAL TOPOGRAPHY.

By this term is understood the relation to the skull of those areas of the brain which are of special surgical importance. For detailed particulars of this subject, information should be sought in textbooks of surgical anatomy and operative surgery. Only the Rolandic area and the fissure of Sylvius will be here referred to, together with an indication of the positions of the centres for the special senses.

The **motor area** is situated in **front** of the fissure of Rolando, and comprises half of the ascending frontal or precentral convolution and that portion of the paracentral lobule lying anterior to the fissure of Rolando.

The areas are inverted in the brain ; thus, the upper third of the area corresponds to the lower extremity, the middle third to the upper extremity, and the lower third to the face and tongue.

The Sensory Area of the Cortex.—The centres for sensation are situated behind the fissure of Rolando. Those for common sensation occupy the ascending parietal or post-central convolution. Those for muscular sensation, and for the recognition of objects and their form by touch, known as the **stereognostic** sense, are situated in the neighbouring portions of the parietal lobe.

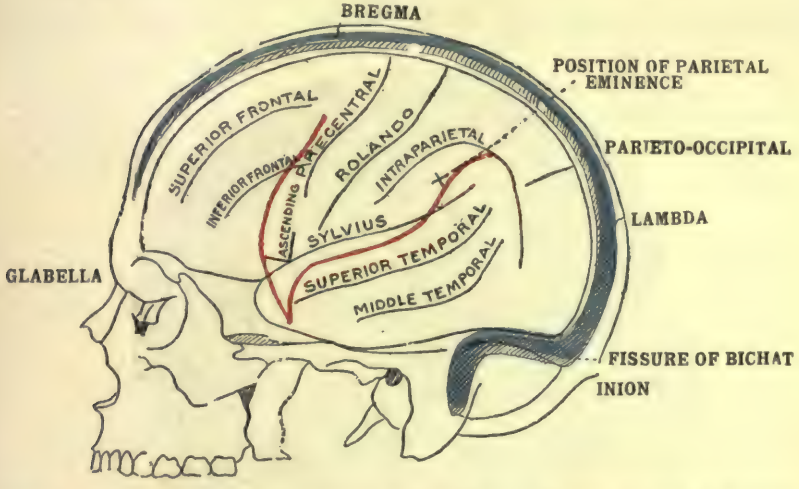


FIG. 45.—DIAGRAM SHOWING RELATION TO THE SKULL OF THE MIDDLE MENINGEAL ARTERY (IN RED), THE SUPERIOR LONGITUDINAL AND LATERAL SINUSES (IN BLUE), AND THE PRINCIPAL FISSURES.

(Stewart's "Surgery.")

To find the fissure of Rolando many methods have been devised, of which two are given :

(*a*) Take a point ½ inch behind the centre of a line drawn from the root of the nose to the external occipital protuberance ; from this point draw a line downwards at an angle of 67½ degrees to a point 2¼ inches behind the external angular process. The fissure is represented by the first 3⅜ inches.

(*b*) *Reid's Method.*—Reid's base line is drawn from the lower margin of the orbit through the external auditory meatus to a point just below the external occipital protuberance. From this line are drawn two uprights—one from the small depression in front of the external auditory meatus, the second from the posterior margin of the mastoid process. The fissure of Rolando extends from the upper point of the posterior line to the point at which the anterior line intersects the fissure of Sylvius.

The **Fissure of Sylvius** is found by taking a point 1¼ inches behind the external angular process and 1½ inches above the zygoma to

$\frac{3}{5}$ inch below the parietal eminence. The first $\frac{3}{4}$ inch represents the vertical limb, the remainder the horizontal limb.

It was formerly taught that the **Motor Centres for Speech** were situated in the **Island of Reil,** within the beginning of the horizontal limb. "It has been demonstrated, however, that this region has nothing in common with the cortical areas presiding over speech production. At most it is but a link between the hearing and speech centres. The speech centre is located in the Sylvian operculum on the left side in right-handed people, and on the right side in left-handed people. It is usually on the left side, since we are generally left-brained just as we are right-handed. This region is known as 'Broca's region,' and disease thereof will cause **aphasia,** or loss of power of speech. Aphasia may be of two kinds—motor and sensory. In the motor variety there is loss of power to co-ordinate the muscles of articulation ; in the sensory variety there is loss of memory for words,

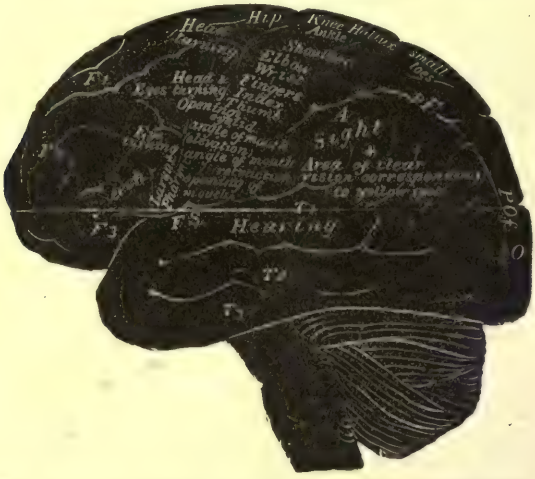


FIG. 46.—THE CORTICAL AREAS OF THE CONVEXITY OF THE LEFT CEREBRUM. (WALSHAM.)

F_1, F_2, F_3, Frontal convolutions ; F_3, centre for speech ; T_1, T_2, T_3, temporo-sphenoidal convolutions ; T_1, centre for hearing ; *A.*, angular convolution, the area of clear vision connected with the yellow spot ; *F.S.*, Sylvian fissure ; *O.*, occipital lobe ; *P.F.*, intraparietal fissure ; *P.O.F.*, parieto-occipital fissure. Recent observations tend to show that in man the sensorimotor areas do not extend much behind the fissure of Rolando, but lie mainly in front of it (Sherrington).

(Stewart's "Surgery.")

called **amnesia.** In the former the patient knows the words perfectly, and can write them, but is unable to pronounce them. The condition may be produced by a plugging of the middle cerebral artery, by cerebral softening, hæmorrhage, or pressure of tumour" (W. F. Campbell, "Surgical Anatomy").

The **Centre for Sight** is situated in the superior and inferior lip of the cuneate lobe (occipital), above and below the calcarine fissure.

The **Centre for Hearing** is situated in the superior temporal convolution (transverse gyri of Heschl).

The **Centres for Taste and Smell** are situated at the anterior end of the hippocampal convolution.

REGIONS OF THE BRAIN ASSOCIATED WITH SPECIAL FOCAL SYMPTOMS.

Frontal Lobe (exclusive of Rolandic area).—The **Prefrontal Area** is not much affected by any lesion as a rule, but mental changes may sometimes be noted. **Postfrontal Area:** At its lower part is situated the motor centre for speech. Injury to this will cause aphasia.

Rolandic Area.—In the **Motor Area, irritation** will cause Jacksonian convulsions of the opposite side; **tumours** cause first convulsions, then paralysis; **trauma** causes paralysis of the opposite side, but not convulsions; **inflammation** causes convulsions, but not paralysis.

In the **Sensory Area** of the cortex, injury causes little disturbance unless the subcortical nerve tissue be also involved, when anæsthesia and a certain amount of paralysis is produced.

Parietal Lobe (excluding the Rolandic area).—Lesions of angular gyrus on left side cause word blindness, and of the upper parietal lobe loss of stereognostic sense.

Occipital Lobe.—Destructive injury or disease causes blindness of the retina of each eye of the same side as the lesion (homonymous hemianopsia). Blindness is permanent if the angular gyrus be also destroyed.

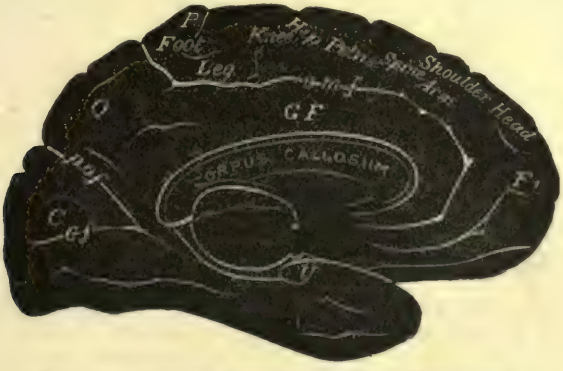


FIG. 47.—MEDIAN SURFACE OF LEFT CEREBRUM.

G.F., Gyrus fornicatus, perhaps connected with general sensation; its impairment causes hemianæsthesia; *C.*, cuneus; *C.M.F.*, calloso-marginal fissure; *Q.*, quadrate lobule; *C.F.*, calcarine fissure; *U.*, uncinate lobule.

(Stewart's "Surgery.")

Temporal Lobe.—Word deafness is the result of a lesion of the left superior convolution, while interference with the centres of taste and smell follow lesions of the uncinate convolution.

Internal Capsule, Caudate and Lenticular Nuclei.—Hemiplegia and partial loss of sensations follow lesions of these parts of the opposite side of the body.

Optic Thalamus.—Contralateral athetosis, with chorea, paræsthesia, and hemianopsia, follow lesions of this structure.

Crus Cerebri.—Lesions cause almost complete or complete hemiplegia of the opposite side, and paralysis of the third motor oculi nerve of the same side.

Cerebellar lesions produce giddiness, vertigo, and ataxia, with reeling gait.

Pons.—If not fatal, an injury will cause paralysis of the opposite side of the body and the same side of the face, with contracted pupils.

Medullary lesions are usually fatal; if not, the circulatory and respiratory centres are disturbed, and there is, perhaps, Cheyne-Stokes breathing.

WHERE TO APPLY THE TREPHINE.

For **brain tumours, abscess, blood-clot,** and **focal epilepsy,** the point must be determined by the localizing symptoms.

For **foreign bodies** the point of operation is that of entrance, as a rule.

For **middle meningeal hæmorrhage,** 1½ inches behind the external angular process and ½ inch above the zygoma.

For **mastoid cells,** ¼ inch behind and above the external auditory meatus, or in the suprameatal triangle, which is bounded above by the posterior root of the zygoma, below by the postero-superior edge of the bony external meatus, and posteriorly by an imaginary line joining these.

For **lateral sinus,** 1 inch behind and ½ inch above external auditory meatus.

CHAPTER XX

INJURIES AND DISEASES OF THE SPINE

Injuries; General diagnosis, strains and sprains, wounds, fractures, dislocations—Secondary effects of injuries: Concussion, myelitis, neurasthenia, paraplegia—Treatment of spinal injuries—Traumatic neuroses—Diseases: Tuberculous disease, abscess, hysterical spine, syphilitic disease, tumours, meningitis, myelitis, actinomycosis, blastomycosis, hydatids, coccydinia, osteomyelitis, periostitis.

THE spinal cord itself is well protected from injury by its position between the bodies and laminæ of the vertebræ. Being slung in its canal by prolongations of dura mater, and protected by the intervertebral discs and by the various curves of the spine, it is not liable to suffer from jars unless the force be a very great one.

The parts most exposed to injury are the **dorsi-lumbar** and the **cervico-dorsal** regions.

GENERAL DIAGNOSIS OF SPINAL INJURIES.

When anyone meets with an accident likely to involve the spine, the case should be gone into carefully, with the following points in view:

(*a*) The history of the accident, which may have been a fall on the head, feet, or back, a sudden violent twist, or the falling of a heavy body on the shoulders or back.

(*b*) The evidence of compression or other injury to the cord or its nerves.

(*c*) The objective signs of injury outside the cord.

Adult life is the usual period in which injuries to the vertebræ are met with. The form of violence is usually indirect when the bodies of the vertebræ are involved, direct when the arches are affected. Acute flexion is a more common form of indirect violence than over-extension or rotation. Fracture alone is uncommon, being usually associated with dislocation; the position is usually between the tenth dorsal and second lumbar vertebræ. If pure fracture is present, it is more usual in the cervical region. Dislocation of the articular surfaces from one another may occur without fracture.

In fracture the cord is usually caught between the fragments, and may be hopelessly injured. Hæmorrhage may occur, giving rise to compression, either around the cord or in its substance. It must be remembered that the cord is made up of numerous segments, which correspond to the vertebræ and spinal nerves. The signs and symptoms will vary greatly according to what segment or segments are injured. The various symptoms may be due to the piercing of the cord

by a fragment of bone, to the cord being caught between the broken ends, to the pressure of a dislocated vertebra or of blood. Similar symptoms may arise from pressure of inflammatory exudate or of a tumour. The history will usually be sufficient to clear up the point, but where there is a coincident injury there may be some difficulty, especially as it may act as an exciting cause to stir up a pre-existing quiescent pathological condition.

Speaking generally, cord injuries cause—

(*a*) Irritation, which gives rise to pain, spasm of certain groups of muscles, rigidity, and marked hyperæsthesia. The reflexes are usually increased.

(*b*) Destruction of a transverse portion of the cord, which produces paralysis, loss of reflexes, and anæsthesia below the lesion. A band of hyperæsthesia exists above the level of the lesion. Later on there will be trophic, vasomotor, and visceral symptoms.

(*c*) Partial destruction of the cord, which produces paralysis limited to one side, and partial loss of reflexes.

SPINAL INJURIES.

Strains and Sprains.—Such injuries are fairly common amongst those engaged in heavy manual labour. They are caused by sudden movements which are also unexpected. The cervical and lumbar regions are those most likely to be affected. The **Signs** are those of a local injury, giving rise to pain and tenderness with some bruising and swelling. The spine is held rigid by the patient. No bad results ensue, unless when the canal is opened by rupture of the ligamenta subflava, when paraplegia may result, owing to pressure on the cord from blood which has entered the canal. When the injury is in the lumbar region, hæmaturia may be a symptom from involvement of the kidney.

Penetrating Wounds.—These are not common, but may result from a fall upon some sharp object, from a stab, or from a gunshot wound. The **Symptoms** are those of the external wound, which may also involve one of the closed cavities with their contained viscera, or may injure the vertebral artery. There may also be fracture of the spine, leading to symptoms of cord pressure, loss of cerebro-spinal fluid, or direct wounding of the cord, and septic changes.

Fractures of the Spine.—May be *incomplete*, involving the spinous processes, laminæ, transverse processes or body ; or *complete*, in which case they are usually associated with displacement, fracture or dislocation. Even in incomplete fractures there are often symptoms of paraplegia arising from concussion or pressure of inflammatory and hæmorrhagic effusions. In complete fracture there are marked local symptoms of pain, swelling, and bruising, and crepitus may be elicited unless impaction be present. Care should be taken not to make any unnecessary movements. There is considerable shock, and usually paraplegia below the injured part. If the cord be badly injured, myelitis will follow and an early fatal issue occur.

The **Prognosis** largely depends on the position of the injury—the higher, the greater the danger—and the extent of the injury to the cord.

Dislocation.—A pure dislocation can only occur in the cervical region. It is usually associated with fracture, and gives rise to symptoms similar to those already described.

Occasionally the occiput has been displaced from the atlas, resulting in instant death.

Dislocations may be unilateral or bilateral. In the former replacement may be attempted, and if successful the patient may recover, as the cord has probably escaped serious injury. In bilateral dislocations, even if replacement can be carried out, death usually results, as the cord seldom escapes without most serious injury.

Secondary Effects of Spinal Injuries.—Concussion may follow severe blows on the back, with or without fracture. There is complete and instant loss of function, together with paraplegic symptoms. As in concussion of the brain, the patient may recover, or death may ensue. There is really contusion of the cord, with small hæmorrhages into the grey matter or membranes.

Chronic myelitis may occur, giving rise to a progressive paralysis.

Spinal neurasthenia will be referred to later.

Paraplegia may arise at once from direct concussion, disintegration of the cord, dislocation, or penetrating wounds. It may occur later on from extramedullary hæmorrhage, pressure of exudate or of callus.

A total transverse lesion will result in paralysis of the area supplied by the segment of the cord; atrophy and loss of reflexes in the particular group of muscles; complete paralysis, and anæsthesia below the injury; a band of hyperæsthesia at the top level of the anæsthesia, due to irritation of nerve roots at the point of injury. There will also be vasomotor and visceral disturbances, bedsores being very likely to develop. There is absence of sweating below the lesion, and this fact has been used by Horsley to determine its level; if $\frac{1}{6}$ gr. of pilocarpine is injected subcutaneously, sweating occurs above the lesion. The test should not be used if the patient is the subject of bronchitis.

When the lesion is at the **top of the sacrum** there will be paralysis of most of the leg muscles, together with anæsthesia below the injured point, except on the front and outer parts of the thighs. There will also be retention followed by incontinence of urine and fæces.

If the lesion pass through the **lumbar enlargement** (12th D. & 1st L. vertebræ), there will be complete paralysis and anæsthesia of the limbs, and paralysis of the bladder and rectum, with incontinence of urine and fæces. Cystitis is an early result, and may carry off the patient.

When the lesion is in the **mid-dorsal** region, there are the above symptoms, together with paralysis of the abdominal muscles, which is a very serious symptom, and retention of urine followed by overflow. By careful treatment cystitis may be avoided, and the patient come to pass water whenever the pressure is sufficient to cause stimulus of the sensory nerves.

In a lesion of the **cervico-dorsal** region there is almost complete anæsthesia of the trunk and paralysis of the intercostal and spinal muscles; respiration therefore becomes impeded, and if any lung trouble, especially bronchitis, be present, death by asphyxia will probably soon occur. Marked priapism is present.

When the lesion is through the **cervical** region below the fourth vertebra, total paralysis and anæsthesia of the body from the arms downward exists. If the lesion is at or above the fourth vertebra, death results from paralysis of the phrenic nerves.

Prognosis in paraplegia will largely depend on the position of the lesion and the previous health of the patient.

TREATMENT OF SPINAL INJURIES.

Strains and **Sprains** of the spine should be treated carefully, or much after-trouble may be experienced. Rest in bed should be enjoined; and if the cervical region be injured, extension should be applied to the head and the nape of the neck supported on a roller pillow. Early massage should be employed, but no active movements allowed till all acute symptoms have disappeared. This is imperative when the patient has any tuberculous tendency.

Dislocation.—There may be an isolated **dislocation of articular processes,** which usually results from a fall on the head and shoulders in such a way that the neck is forcibly flexed and twisted, the articular process of the upper vertebra passing forward to lie before that of the vertebra below. The condition is usually unilateral, and is met with in the cervical region as a rule.

Reduction should be attempted without delay, otherwise the displaced vertebra becomes fixed in its new position. An anæsthetic is necessary. Gentle extension should be exerted on the head so as to exaggerate the deformity, loosen the ligaments, and make the locked articular process movable. The head is then forcibly flexed towards the opposite side, and the normal position may be restored. Rest should follow reduction.

When **both articular processes are dislocated,** the condition is usually met with in the lower cervical region. Reduction is difficult, and even if successful the prognosis is not good, since the cord is usually very severely injured.

Dislocation with fracture is the more usual form of severe spinal injury, since the force that causes a dislocation of the spine is usually more than sufficient to produce fracture. In this condition there is generally bilateral dislocation of the articular process and fracture of the bodies of one or more vertebræ. The situation is usually dorsal or dorso-lumbar, and the injury is usually produced by a heavy weight falling on the bent back, the spine fracturing at the flexion angle, and not at the point of impact.

The treatment deals with the cord itself to a great extent, since the symptoms are referable to its injury. The patient should not be moved to enable the spine to be inspected, but a diagnosis arrived at by a consideration of the history of the accident, by observing the condition of nerve function below the seat of injury, and by passing the hand under the back, where pain, tenderness, and swelling, will be found over the injured vertebræ. If swelling does not mask the sign, the spinous processes of the injured vertebræ will be found more prominent than normal, while the process immediately above them is depressed. Loss of power and sensation below the lesion is usually a marked symptom. Replacement of the bones by traction, accompanied by manipulation, will as a rule present little difficulty, since the ligaments are usually much torn. A roller pillow should be placed under the fracture to relieve pressure by the traction action of the weight of the body. Operative treatment is of little avail, since, as already stated, it is the injury to the cord rather than to bone which marks the case and renders the prognosis so bad.

When the fracture dislocation involves the separation of the atlas and axis, death is instantaneous. Occasionally the odontoid process is fractured, but held in place by the transverse ligaments. Little can be done for such a case, and death may take place suddenly some

time after the accident, owing to displacement occurring from softening of the transverse ligaments.

Fractures of the Vertebral Arches and Spinous Processes.—These are usually the result of direct injury, as from a weight falling on the back, a blow, or a bullet-wound. There is usually bruising of the overlying parts and irregularity of the spinal line; crepitus may be elicited. The lower cervical and dorsal regions usually suffer. The cord and spinal nerves in many cases do not suffer; when this is the case, treatment consists in rest by means of extension, which should be kept up till the bones are united. If both laminæ are fractured, the posterior arch is driven in, and the cord pressed upon directly or by blood effused between the dura and the bone; when this happens, the pressure must be relieved and the bone raised or cut away by means of the operation of laminectomy.

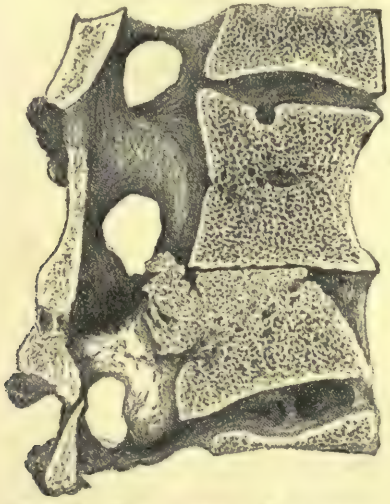


FIG. 48.—FRACTURE OF VERTEBRA.
(Sluss, "Emergency Surgery.")

Fracture of the Bodies.—This is due to great force, as a fall from a height on the head, buttocks, or feet, which compresses the bodies to the extent of fracturing them; hence the term **compression fracture** which is applied to this form of injury. When the force is applied to the head, the lower cervical or upper dorsal are the vertebræ involved, and the lumbar when the patient falls on the feet or buttocks. There may be no external signs of injury to the spine, but coincident fracture to the sternum is often present, as well as injury to the head and limbs and internal organs. If there be marks of **spinal** injury, they consist of prominence of the vertebra above the injured one, and local pain and tenderness. There are seldom cord symptoms, but nerves emerging at the point of injury are often crushed, giving rise to girdle pains. If there are **cord** symptoms, operative procedure should be undertaken, otherwise prolonged rest with extension should be adopted. In injury of the cervical region, a pillow should be put under the neck and extension applied to the head; in the lumbar region the pillow is put under the loins and extension applied to the lower limbs. The

patient is allowed up in six or eight weeks, and a supporting jacket worn for another four weeks.

It sometimes happens that the injury is not recognized, and the patient continues at his occupation. Nature seeks to carry out repair, but there is not sufficient rest to make it effective, so that the condition becomes worse by progressive softening of the injured vertebra, and perhaps those next to it also become affected. Meanwhile the patient suffers from increasing pain in the back, round the body, and in the limbs. On examination of the back, a projection which is both tender and painful is seen. While the softening process is active the patient should be kept in bed, and afterwards a supporting jacket worn for some time. Unless the case has been seen early, there will be a permanent deformity, due to the softened area becoming fixed in a false position when the process is arrested by the fusing of two or more vertebræ. This condition is referred to as **traumatic spondylitis,** and may be due to the severe spinal injuries as well as compression fracture.

Penetrating Wounds.—It is the opening into the membranes of the cord, or pressure on the cord by broken bone, which makes this wound dangerous. When the laminæ are driven in, they should be elevated by operative procedure. When the nerve cords are severed in the lumbo-sacral region, they should be sutured, laminectomy being performed to reach them. Occasionally the cord itself may be severed by the accident, when operation is useless. The proposal to unite the two ends of the cord need not be entertained with any view of restoring function.

Cord Injuries.—Almost any severe injury may cause **concussion** or **contusion.** When either results, the treatment consists of rest, the application of ice to the spine, and the use of the catheter, since the power to micturate is for the time being lost.

When the cord is **completely divided,** usually by complete dislocation, treatment resolves itself into prevention of septic complications, arising especially from cystitis.

Partial lesions, arising usually from incomplete dislocations or fractures, should be treated actively by the performance of laminectomy when there is reason to believe that pressure is being exerted by blood-clot or a displaced fragment of bone which may be removed by operation. Apart from this, treatment should be by rest and the relief of symptoms, paying special heed to bladder conditions. The condition of the cord in these injuries is one of laceration, severe contusion, or partial rupture, and is often of such a nature that cure cannot be effected, spastic paralysis following from organic changes in the cord.

The symptoms calling for treatment in partial lesions of the cord are mainly those due to interference with motor power. There is paresis of the motor area below the lesion, but it is more marked on one side, and the more distant parts are most affected. Vasomotor disturbances are also present. The deep reflexes are often first lost, but later they are exaggerated. Sensation is not much disturbed as a rule. The patient is usually aware that the bladder or rectum require emptying, but is unable to perform the act. The symptoms may be confused in partial lesions by hæmorrhage into the cord, causing those of pressure in addition to symptoms due to the cord lesion ; the former are, however, temporary.

When the case is progressing favourably, the patellar reflexes return, then sensibility to touch, pain, and heat or cold, in the parts supplied from the lower sacral segments. The power of flexion returns before that of extension, and flexion of the toes is usually the first movement seen.

Injury to Nerve Roots.—When these are alone affected by accidents to the spine, interference with sensation is marked in contradistinction to partial cord lesions; there is radiating and neuralgic pain in the area supplied by the injured nerves. Motor paresis is present, and may disappear quickly or be more persistent and followed by atrophy of muscles.

Treatment is on much the same lines as that for partial lesions of the cord.

Spinal Hæmorrhage.—As the result of any form of injury to the spine, hæmorrhage may take place either around the cord (**extramedullary**) or into its substance (**intramedullary**). In the former variety there is at first irritation, and later pressure symptoms. It should be remembered that these may occur at a lower level than the injury (**gravitation paraplegia**), owing to the blood running down the canal and collecting, then giving rise to symptoms of paralysis spreading from below upwards.

The patient should have rest in the prone position, with ice to the spine and ergot internally. The bladder and rectum will both require as a rule to be evacuated. If the pressure symptoms do not abate, but tend rather to increase, the tension should be relieved by lumbar puncture or laminectomy.

When the bleeding is intramedullary, it usually occurs in the lower cervical region. Paralysis is an early symptom, and if the pressure of the blood is not relieved by absorption it may cause destruction of the substance of the cord, in which case the paralysis will be permanent. As a rule, however, the symptoms soon clear up under treatment. Operative procedure is, of course, contra-indicated, since the pressure is caused within the cord. The general treatment is as for extramedullary hæmorrhage.

TRAUMATIC NEUROSES.

Under this heading may be included all conditions produced by mental and physical shock to the brain and spinal cord, and termed variously **traumatic hysteria, railway brain,** and **railway spine.**

It was at first thought that the condition was one of injury to the meninges of the cord, with resulting inflammation; then came the theory of pure hysteria; and now the generally accepted theory is that a trauma causes symptoms which are hysterical in character and sometimes simulate organic lesions. There are few conditions which cause more difficulty in diagnosis and treatment, and it is well not to err on the side of a cheap cynicism which regards the injured man or woman as a pure neurotic or impostor, nor yet, on the other hand, to exclude the malingerer from our mental calculations.

It used to be the fashion to laugh many such cases out of court, and to think that a patient who sued a carrying company for "railway spine" was a fraud of the first water. Only those who have come

in contact with some of these cases can realize the heartrending condition to which many a healthy man and woman may be reduced by a severe jar to the spinal cord.

The causation is not necessarily a physical injury or shock, nor is it always associated with railway accidents, though it frequently follows them, the reason for this probably being the sudden, unexpected nature of the accident and the amount of nerve strain associated with it. A purely mental cause may result in the symptoms of traumatic neurosis, and yet the name not be inapplicable, since the strain and anxiety is usually associated with some accident, or narrow escape from accident, in which the patient has been directly concerned, although not injured. Thus, a man on the footplate of a locomotive may experience such a shock by reason of seeing a person killed by his engine or by narrowly averting a collision. The commander on the bridge of a ship may experience a like shock by seeing a fishing-smack run down, or his ship just escape a collision.

Naturally, many workmen, especially in connection with our great railways, are liable to traumatic neurosis, but not only these workmen. A man in any employment who receives an injury far short of that which would produce fracture or concussion may develop the trouble. In such cases there is probably some existing debility of nerve tissue due to heredity or coexisting disease. The child of a syphilitic parent, though not himself suffering from any apparent manifestation of the disease, is frequently a neurasthenic, developed or potential, who may but await such an accident or strain to develop his taint. So with the acquired syphilitic and the alcoholic. It must, however, be admitted that occasionally a case occurs after slight injury in which it is impossible to trace any history which would point to decadent nerve tissue. It is probable that this is from lack of information rather than absence of cause.

The **Pathology** of the condition is exceedingly obscure. Usually it is quite impossible to detect any abnormality in brain or spinal cord ; sometimes small hæmorrhages are observed, and very rarely there are definite lesions of the nerve tissue ; it is open to question whether in such cases the lesions were not existent at the time of the accident, the latter acting as an exciting cause of the symptoms. In such cases there is often an arterio-sclerosis of the arteries of brain and cord. It is probable that the condition produced is largely a mental one, and pathological changes are too subtle to be recognized. It is at least very rare for organic disease to follow traumatic neurosis, though it would be going too far to say such a thing was impossible.

Symptoms.—These will vary with the type.

(*a*) In what may be called the **simple** cases the symptoms appear within a few weeks of the date of the accident. There is headache and restlessness, and sleep is hard to induce. The mental, and to some extent even the moral, nature of the person may be changed. There is considerable pain in the back and numbness of the limbs. In those who are inclined to pessimism and melancholy, these characteristics will increase chiefly because the mind is constantly dwelling on the condition or supposed condition of disease present. The general health is not much interfered with at first. Examination reveals little beyond a general nervousness, evidenced by increased reflexes and cardiac excitement, while the pupils may be unequal. The brain or the spinal symptoms may predominate according to which organ is the site of injury.

(*b*) Some cases are of a more **hysterical** order, and lack of control is the predominant feature. The patient easily gives way to tears, and such are often present when describing symptoms ; the patient may be a big, able-bodied man, which emphasizes the condition present. A prominent symptom is tremor of the entire body, while anæsthesia of one side may be present. Sight is often interfered with, the patient complaining that since the accident he cannot see as well as formerly. Various conditions indicating loss of control may be met with, as in the case reported by Osler, in which a man who had been struck by an electric tram was breathing at the rate of 130 to 150 respirations per minute. This, of course, might be an intentional increase for a purpose, but it could not be maintained, nor could a very much increased heart-rate, which is sometimes met with, be induced.

(*c*) There remains another class of cases in which the injury is usually that of **concussion of the spine,** where the symptoms point to **organic disease.** Such symptoms may occur early or be a remote occurrence long after the date of the accident, and when the connection therewith may be doubted. At first the usual symptoms enumerated above manifest themselves within a fortnight of the accident, but later on the sensory and motor changes show themselves, and lead to the serious question of organic disease being present as a result of the injury received. Certain areas of the skin are anæsthetic, and this condition may extend for a considerable distance down one side of the body. There is pain on handling some parts. The special senses are as a rule abnormal. The reflexes are irregular. Monoplegia is present in many cases. The presence of monoplegia with disturbance of sensation, and not accompanied by disturbance of electrical reaction, is a fairly safe guide to the case being one of traumatic neurosis; but such cases must be carefully watched for fresh symptoms, and on no account should an opinion be given hastily, since it cannot be denied that here and there a case has been reported of organic lesion following trauma.

Diagnosis.—The surgeon has by no means an easy task before him when he sets out to diagnose a case of concussion without external injury. If the case were difficult before the passing of the Workmen's Compensation Act, it is doubly so now, for the injured workman has an Act of Parliament at his back which makes it worth his while to magnify his troubles. Without casting any unjust aspersion on the honest workman, we must be alive to the possibility of simulation, especially with regard to injuries of the nervous system. It is wonderful how the malingerer learns of the symptoms he has to simulate, and the only pity from his point of view is that he usually overdoes them, and thus betrays himself.

It must be remembered that following on any serious accident there is naturally a period of excitement and alarm, which may last some time, and is to be distinguished from true traumatic neurasthenia.

The surgeon has, then, in examining a case, to decide—

1. If the case is one of excitement and fear.
2. If it be simple neurasthenia, the hysterical form, or that simulating organic lesion.
3. If organic lesion is present.
4. If the case is one of simulation.

The first is easily disposed of by observation and examination, and, by consideration of the symptoms given above, a decision can usually

be arrived at as to the type being simple or hysterical. The real difficulty presents itself in deciding as to whether organic trouble is present, and, if so, if it is due to the accident. It is well, therefore, to remember that when a case presents the symptoms of **disturbance of sensation, with paralysis of the monoplegic type, defective vision, contractures of muscle unattended with wasting or abnormal electrical reaction, and some form of hysteria, it is neurotic in origin**; while if indications of **sclerosis are present, combined with bladder symptoms and atrophy of the optic nerve, the case is organic.** Whether the latter is due to the injury is a grave question to answer, but with our present knowledge, so long as there is no gross external injury, it may generally be answered in the negative, with, however, the reservation that similar symptoms sometimes develop after injury. The malingerer, as already stated, will probably overdo himself, and it is always well to examine him twice. On the second occasion he will probably mix up his symptoms or magnify different ones. It is well not to conclude that a man is a malingerer because his symptoms become worse when he tries to work. In the case of a man who was found later to be suffering from disease of the brain this was a marked symptom.

The symptoms of a traumatic neurosis may be long delayed, and may manifest themselves after a considerable interval from the time of the accident, the patient in the meantime having shown no signs of injury.

Prognosis.—On the whole, prognosis is good in traumatic neurosis. The fact that a patient improves in his condition after he has been awarded compensation by no means proves that he is a schemer, since uncertainty and the excitement of legal procedure are just the conditions to prolong the symptoms.

Sometimes cases do badly, probably owing to the patient being the unfortunate possessor of an unstable nervous tissue due to heredity or disease. As already pointed out, in occasional cases in which injury has been probably an indirect rather than a direct cause, signs of organic lesion manifest themselves; the prognosis is then bad.

Treatment.—This is largely a tonic one for the general condition of neurasthenia **after** the legal claim has been settled. Electrical treatment is of benefit in some cases. Particular symptoms have to be prescribed for as they arise.

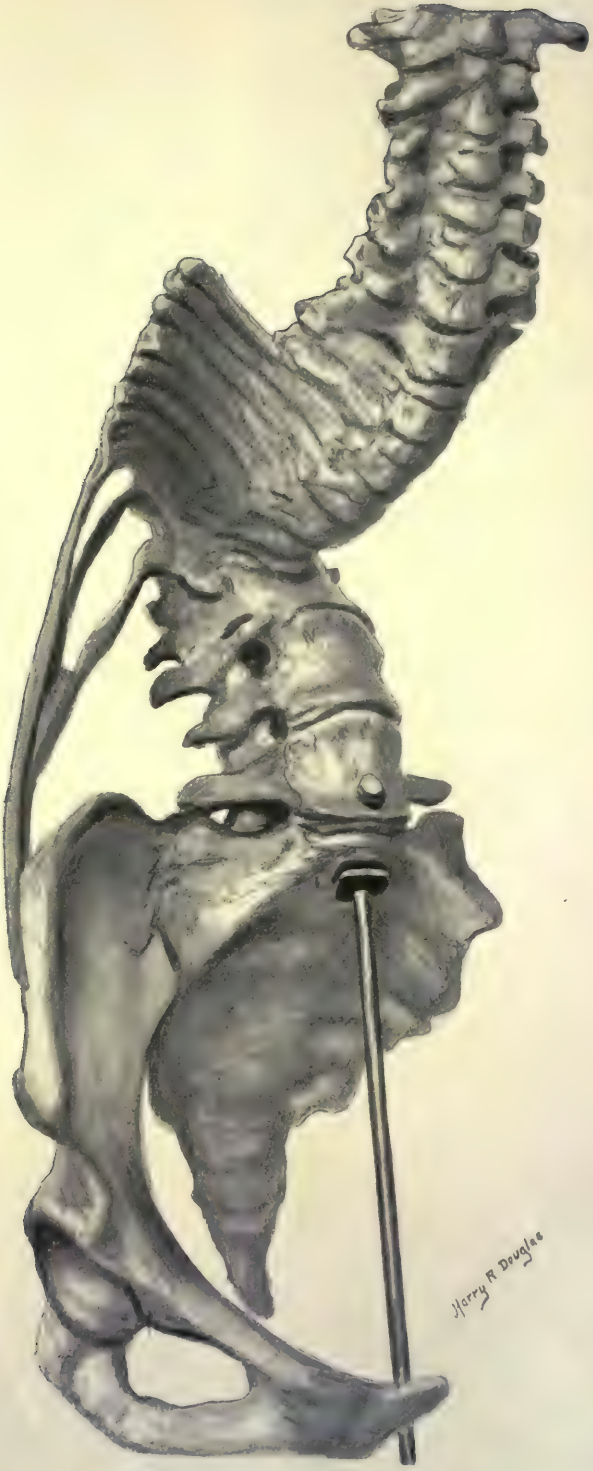
SPINAL DISEASES.

Tuberculous Disease.—The tubercle bacillus carried by the blood-stream is deposited in the anterior part of the body of a vertebra, producing **osteomyelitis,** or in the deep layer of the periosteum on the anterior surface of a vertebra, producing **periostitis.**

The disease differs considerably in its course and results, according to which type is produced.

In **children** as a rule **osteomyelitis** is the form met with. An infiltration of the marrow occurs, which produces softening of the anterior part of the bodies of the vertebræ affected; caseation and suppuration follow, and gradually the disease spreads to adjacent intervertebral discs and neighbouring vertebræ. A sequestrum sometimes forms, particularly in the lumbar region. The pus finds its way to the front,

PLATE LI.



ANGULAR CURVATURE OF THE SPINE.

(Museum, Queen's University of Belfast.)

[To face page 387.

and sometimes to the sides, of the bone, and under the anterior common ligament. Occasionally pressure is produced on the spinal cord by the pus working backward and collecting outside the dura.

A time is reached in the progression of the disease when the weight of the superior sound vertebræ becomes too much for the diseased ones to support. The front part of the bodies being that most seriously affected, they sink in anteriorly; while the posterior part and the spinous processes project more or less, and at the same time prevent dislocation or collapse, and the cord is protected from pressure. Usually two vertebræ are affected, and the projection of the spinous processes is angular; if more vertebræ are affected, the angle is less acute, but is seldom so obtuse as to merit the term "angular curvature," which is a contradiction in terms.

It is to this angular deformity that the name of **Pott's disease** is often applied, but it is not correct to limit the designation to the deformity alone. The name is derived from Percival Pott, who first described the disease in 1779; it may exist without deformity, though in children, who supply 50 per cent. of the cases, it is usually present.

In **adults** the **periosteal** form of the disease is the more common. It begins in the deeper layer of the periosteum covering the front of the vertebræ, extends along the surface of the bones, producing extensive superficial caries. In its course the disease often attacks the margins of the intervertebral discs, and spreads between them to the adjacent vertebræ. Abscess formation between the bone and the periosteum and under the anterior common ligament is a frequent occurrence in this form. Deformity, when present, is not of the angular variety, but, owing to the number of the vertebræ usually effected, is rather a wide curvature.

Sometimes the tuberculous process attacks the dura mater, setting up **pachymeningitis**; while **myelitis** may result from interference with the blood-supply of the cord, owing to the meningitis present.

A **natural cure** may result from the bodies of the vertebræ becoming ankylosed, which usually causes an increase of the deformity, owing to the contraction produced by cicatrization. It should therefore be remembered that **an increased deformity does not always indicate an increase of the disease.** A cure of this nature can only take place when the disease becomes non-progressive, but may occur without active treatment.

Symptoms—(*a*) *Pain.*—This is first rather a condition of weariness and of feeling very tired after a small amount of exertion. Pain of a dull, aching sort is next experienced, and this is increased by any form of movement which causes jerking or bending of the spine. Pain may be felt along the course of the nerves which emerge from between the diseased vertebræ. There is usually some tenderness over the spinous process of the affected bones, and occasionally there is absence of any pain.

(*b*) *Rigidity.*—This is produced by reflex contraction of the muscles passing over the diseased vertebræ, owing to the pain caused by movement. When the hand is placed over the affected area, and the patient asked to stoop or turn, the segment of the spine is found to move as a whole, instead of the individual vertebræ.

(*c*) *Deformity.*—The most usual is antero-posterior curvature, already referred to. Its extent depends on the position of the disease, early diagnosis, and efficient treatment. It may be avoided in many cases. Occasionally there is a lateral deviation, due in the early stages to

excessive muscular contraction on one side, and in the later to a one-sided destruction of the vertebræ.

(*d*) *Abscess.*—A retropharyngeal abscess may form in disease of the upper **cervical** region, which may present towards the pharynx as a fluctuating swelling causing difficulty in deglutition and respiration, or it may present behind the posterior border of the sterno-mastoid muscle. In the **cervico-dorsal** region an abscess comes to the surface at the lower part of the posterior triangle, in the axilla, or points in the posterior mediastinum. In the **dorsal** region the abscess may present behind the transverse processes, the pus having travelled back along the posterior branches of the intercostal vessels. If the pus travels forwards along the course of the lateral cutaneous branches, it presents about the middle of the rib, and must be distinguished from an abscess arising from caries of the rib. In adults or in children, when the disease is on the anterior surface of the bodies, especially of the lower dorsal vertebræ, a psoas abscess may result, owing to the pus spreading down the pillars of the diaphragm. In the **dorsi-lumbar** region abscess formation usually takes the form of a **psoas abscess,** which is a collection of pus in the sheath of the psoas muscle; the pus spreads downwards towards the iliac fossa or into the thigh under Poupart's ligament, behind and outside the femoral vessels. If the pus travels along the posterior branches of the lumbar vessels, a **lumbar abscess** is formed, which points between the latissimus dorsi and external oblique muscles. In the **lumbo-sacral** region the pus may form an **iliac abscess.**

Symptoms referable to Cord and Nerves.—If the spinal cord is pressed upon, there will be weakness and paresis of muscles below the seat of injury, with exaggerated reflexes; and if pressure is unrelieved, spastic paralysis will develop. If degeneration of the cord occur, there will be wasting of muscles and tendency to deformity, with loss of reflexes.

Treatment.—This has for its object the cure of the disease and the prevention of deformity. Constitutional treatment of the disease causing the local condition is combined with that for the spinal lesion. For the latter, perfect rest in the recumbent posture should be adopted till all symptoms of active disease have cleared up. This treatment should be carried out under the best environment possible. During the period when the symptoms are acute the spine should be immobilized by means of extension and counter-extension with weights and pulley. Later on a double Thomas's splint should be adopted, and the patient got into the open air. When the patient has recovered, and not before, some form of plaster jacket should be used to support the spine for a time.

Operative procedure may at times be adopted, when it is fairly certain that the disease is confined to the neural arches, or when the cord is being pressed upon by granulation tissue or a sequestrum.

For deformity resulting from Pott's disease, and its treatment, see Chapter XIV.

Hysterical Spine.—This is a condition which may be confused with Pott's disease. It occurs in young females of the neurotic type. Pain is referred to the cervico-dorsal or dorsi-lumbar region, and examination is rendered difficult owing to the presence of hyperæsthesia. An appearance of deformity may be present owing to the way the girl holds herself. This causes a projection of part of the spinal column, which may be reddened by the pressure of corsets.

Diagnosis from serious disease may be made by noting that there is no rigidity, and that the spinal column is freely movable.

Treatment should be directed to improvement of constitutional conditions and the combating of hysterical tendencies.

Tuberculous Disease of Sacro-Iliac Joint.—This is usually secondary to disease of the ilium, sacrum, or lower lumbar vertebræ, but it may be primary. The condition is usually met with in young male adults.

Symptoms.—Pain, which is increased by movements of the lumbar and abdominal muscles of a sudden or violent character, such as sneezing or straining at stool. Tenderness on pressure over the joint, as in pressing the iliac bones together or on abducting the limb with the pelvis fixed. There is wasting of the thigh and gluteal muscles. A marked limp is present with a characteristic attitude, caused by the patient throwing his weight on the sound limb and tilting the affected side of the pelvis downwards while he flexes the hip and knee joints of the affected side. The anterior superior iliac spine projects on the diseased side, and the limb **appears** to be longer than its fellow. An abscess usually forms, and may present posteriorly over the joint, anteriorly as an iliac abscess, or, the pus gravitating downwards, appear through the sacro-sciatic foramen as a subgluteal abscess ; it may even reach the ischio-rectal fossa and the perineum.

The pain causing the condition should be diagnosed from lumbago and sciatica, and from hip-joint disease by the fact that the **movements of the hip-joint are not restricted.**

Treatment.—When diagnosed early, the patient may get about on crutches with a patten on the foot of the sound side. When the disease is more advanced there should be complete rest in bed with extension. Operation may be required to open an abscess or to relieve pain. Subsequently a poroplastic jacket should be worn.

Syphilitic Disease of the Spine.—Gummatous disease attacks the vertebræ, usually in the upper cervical region, of adults who are the subjects of acquired syphilis. This may closely resemble Pott's disease in its clinical manifestations, but is more sudden in onset, while the progression is more rapid. The bone soon becomes extensively involved, though abscess formation is not common. Pain is often severe, especially at night. Later on there may be slight angular curvature.

The **Diagnosis** is usually helped by the presence of other indications of syphilis and by the effect of antispecific treatment.

Treatment.—Constitutional for the disease, and local for the condition present, as in tuberculous disease.

Spondylitis Deformans.—Arthritis deformans of the spine has already been referred to under Deformities in Chapter XIV. and Diseases of Joints in Chapter XIII., and rare illustrations are shown in the latter chapter of the disease attacking the cervical region of the spine.

Tumours.—Sarcoma of the spinal column is met with as a primary tumour, and gives rise to symptoms which may be mistaken for those of Pott's disease, or possibly of arthritis deformans. It is to be distinguished from these conditions by the character of the pain, which is much more severe, and by the continuous progression of the disease, which is not retarded by treatment. If the growth encroach upon the canal, the cord may be pressed upon and give rise to special symptoms,

according to the area affected. The disease is frequently met with in the sacrum, where it gives rise to severe pain, resembling sciatica, by implication of the sacral nerves.

Carcinoma is met with in this situation as a secondary tumour, the primary focus being as a rule in the breast. Extensive softening of the bone occurs, and deformity may occur from the same cause as in Pott's disease. The pain, again, is more severe than in tuberculous disease, and may be referred to various points in the course of the nerves having their place of outlet near or at the affected area. Paralysis of a very rapid kind follows pressure of the tumour on the cord, and when in the cervical region interference with respiration will hasten the fatal termination. Pain, early paraplegia, and incurvation, are the most diagnostic **symptoms.** The pain from involvement of the nerve roots is most severe in the early stages ; later on, as the disease advances and paralysis sets in, the pain decreases. The disease is found sometimes to be higher up than the symptoms indicate.

Treatment may be undertaken to relieve symptoms, and sometimes, if the disease is not widespread, it may effect a cure. It consists in the performance of laminectomy with removal of the affected bone.

Tumours of the Cord.—As already pointed out, tumours having their origin in the bone may press upon the cord ; but apart from these there are certain tumours of the cord and membranes, which may be divided, according to their situation, into—

(*a*) **Intramedullary.**—These are usually sarcoma, glioma, or of tuberculous origin, and, infiltrating the cord, render surgical treatment almost hopeless.

(*b*) **Meningeal.**—These are generally sarcomata, but hydatid cysts and fibromata may be met with. All varieties are sometimes multiple.

(*c*) **Extradural.**—Tumours in this position are uncommon ; when met with, they are usually sarcomata and lipomata. They should be removed before the cord is implicated.

Symptoms.—These will depend on the position of the tumour, and whether only nerve roots or the cord also is pressed upon. When the former, there is pain, either girdle or of a shooting character in the limbs, according to the level of the pressure. When the cord is pressed on, the pain is of an intense character and has relation to the segment first affected ; one-sided at first, it later becomes bilateral, and the area of pain is also one of anæsthesia, while there may be a zone of **hyperæsthesia** above the area of anæsthesia. Pain is an early symptom in extramedullary tumours. Later there is paralysis, preceded by motor paresis and followed by spastic paraplegia. When the pressure is unilateral, the paralysis will of course be on the same side, and the loss of sensation on the opposite one. The bladder and rectum become paralyzed, and cystitis is a frequent complication.

Treatment.—It is a wise measure to start with antisyphilitic treatment, to exclude the possibility of the tumour being a gumma. When this is excluded, operative procedure may be considered for meningeal and extradural tumours. When removal is impossible, it has been suggested that the posterior nerve roots should be divided in the neighbourhood of the tumour in order to relieve pain. Spinal puncture sometimes relieves symptoms.

Spinal Meningitis.—This may be acute or chronic. The former is due to trauma, or is secondary to acute meningitis of the brain ; in the latter case involvement of the membranes of the cord is evidenced by rigidity of the cervical muscles and retraction of the neck, girdle or limb pains, spasm of the muscles of the back and limbs, increased reflex excitability. When the theca of the cord is primarily affected, spinal symptoms are first produced ; but the cerebral membranes later become involved, and a general leptomeningitis results. Lumbar puncture is useful to relieve symptoms, but little can be done to arrest the progress of the disease.

The **chronic variety** probably owes its origin to syphilis, though in some cases no such cause can be ascertained. The disease appears to spread in an upward direction as far as the mid-dorsal region.

The symptoms consist of diffuse pain and weakness of the legs ; this is attended with spasticity, first in one leg, then in both, and may go on to complete paraplegia. There is also partial anæsthesia, extending usually as far as the sixth or eighth dorsal root. At times slight angular curvature is present.

Treatment.—As the condition is attended with a considerable increase of cerebro-spinal fluid, associated with shrinkage of the cord, the treatment is directed to opening the theca and washing out with a 1 in 1,000 mercurial solution, with subsequent inunction of mercurial ointment. Little good has followed the use of drugs.

Spinal Myelitis.—This term is applied to changes in the cord the result of trauma, pressure, toxic poisoning, and syphilis, the latter being the most common cause.

Treatment should be directed to removing or neutralizing the cause, and preventing untoward results, such as cystitis and bedsores.

Actinomycosis; Blastomycosis; Hydatid Cysts.—These are occasionally met with in the spine, and may be mistaken for tuberculous disease.

Coccydynia.—A condition of severe pain in the region of the coccyx, especially on sitting and during defæcation.

It is due either to a neuralgic condition occurring usually in neurotic females, when it should be treated by drugs, or to trauma, producing fracture or dislocation of the coccyx, when the latter should be removed.

Acute Osteomyelitis.—A rare condition affecting the vertebræ of the cervical and lumbar regions.

It is characterized by severe pain, fever, rapid formation of pus, and, when spreading to the meninges of the cord, by the symptoms of septic meningitis. This is more likely to occur when the disease begins in the arches of the vertebæ.

Treatment consists in applying extension to the spine, and opening the abscess if detected. The condition is usually fatal.

A **Periostitis** of the vertebræ with much milder symptoms is also met with. Recovery is the rule.

For **Congenital and Static Deformities of the Spine** see Chapter XIV.

CHAPTER XXI

INJURIES AND DISEASES OF THE FACE AND MOUTH

The face: Wounds, burns, boils, carbuncles, anthrax, lupus, tumours—The lips: Macrocheilia, cysts, strumous lip, double lip, ulcer, tumours—The mouth: Stomatitis, tumours, tuberculous disease—The jaws: Septic conditions, phosphorous necrosis, tubercle, syphilis, actinomycosis, tumours, arthritis of temporo-maxillary joint, fixation of jaw—The tongue: Wounds, ulcers, glossitis, tumours, congenital malformations, nervous affections—The salivary glands: Infective conditions, Ludwig's angina, tuberculous disease, salivary calculus, obstruction, fistula, tumours, injuries to the salivary gland.

THE FACE.

Wounds.—These may be incised, punctured, or contused. All bleed freely, owing to the good blood-supply of the face, and for the same reason healing is rapid and repair good.

The dangers of an **incised** wound are—

Injury to one of the large arteries which are superficially placed—*i.e.*, the facial and temporal.

Injury to nerves : Division of the facial, giving rise to paralysis of the muscles of expression ; division of the supra- and infra-orbital leading to loss of sensation in the part supplied.

Injury to Stensen's duct, which may lead to the formation of a salivary fistula.

The dangers of **punctured** wounds lie chiefly in the risk of puncture of the orbit, the cranium, or the antrum of Highmore, with subsequent risk of sepsis.

The danger of **contused** wounds, especially those produced by explosions, lies chiefly in injuries to eyesight, and subsequently to the development of erysipelas or tetanus.

After **Burns** of the face, cicatricial contractions may lead to great deformity of the eyelids, nose, and mouth.

Boils, Carbuncles, Anthrax, etc., may appear on the face, but call for no special mention here, except to note that general infection and intracranial complications may take place readily.

Lupus is frequently met with on the face. For further reference to these conditions see Chapter VIII.

Tumours.—**Epithelioma** occurs most frequently at the edge of the lip, its next most frequent situations being at the outer angle of the eye and the outer margin of the nostril. It is met with chiefly in middle-aged or elderly males, and usually develops after prolonged irritation or in some pre-existing scar, etc. It usually begins as a hard nodule or as a papillary growth, which soon breaks down, to leave an ulcerated surface. Excision or X-ray treatment should be adopted.

Other tumours met with are rodent ulcer and melanotic cancer, as well as various forms of cysts, nævi, neuromata, and adenomata (see Tumours, Chapter VIII.).

THE LIPS.

Macrocheilia.—A congenital lymphangioma in which the lip or lips project and the mucous membrane is everted. A wedge-shaped piece may be removed to effect a cure.

Mucous Cysts.—Small round tumours of a bluish shade growing from the inner surface of the lips, and containing a glairy fluid. Removal of cyst and underlying mucous membrane is the best treatment.

Strumous Lip.—This is a thickened condition produced by chronic œdematous infiltration in young children of the so-called "strumous type." The lip is often everted, exposing the mucous membrane. This may necessitate the removal of an elliptical piece from the inner aspect of the lip. General constitutional treatment should be adopted.

Double Lip.—A condition of hypertrophy of the labial glands met with sometimes in youths. If disfigurement is great, the glands may be removed with some of the mucous membrane.

Tuberculous Ulcers may develop on the lips of those who are the subjects of advanced pulmonary tuberculosis. They should be scraped, and painted with pure carbolic or a 20 per cent. solution of lactic acid.

Syphilis.—In the primary stage the lips may be infected by a true chancre having characteristic appearances, or it may show itself as a mere crack or fissure. In the second stage mucous patches or ulcers sometimes develop. In the third stage gummata may appear, and are liable to be mistaken for epitheliomata.

In hereditary syphilis deep fissures are often found, which leave characteristic scars radiating from the corners of the mouth.

Tumours.—Nævi are fairly frequently met with either on mucous membrane or skin.

Epithelioma is met with on the lower lip of middle-aged and elderly men, and usually follows chronic irritation. It occurs as a hard ulcer or a fungating mass, and spreads along the lip to the angle of the mouth, and may finally invade the jaw; the glands, submental and submaxillary, are early involved.

The growth, together with the infected glands, should be removed freely and early. When inoperable, benefit may be obtained by the use of X rays or radium.

THE MOUTH.

Stomatitis.—An inflammation of the mucous membrane. The condition is divided into—

(*a*) **Catarrhal,** which is usually caused by a decayed tooth or septic wound. The mucous membrane is swollen and red, and secretes a large amount of viscid mucus. Small ulcers are developed by the shedding of the epithelium.

(*b*) **Aphthous,** which occurs in unhealthy children as patches of white surrounded by a red zone. These may run together and form ulcers, and spread so as to cover nearly the whole of the mouth.

(*c*) **Thrush,** which closely resembles the aphthous form, but is due to the *Oidium albicans*, a fungus of sour milk. The condition develops during teething.

(*d*) **Ulcerative,** which occurs in adults, particularly during acute fevers or in debilitated subjects who have bad teeth.

(*e*) **Mercurial.**—This is a special form of the ulcerative variety met with in syphilitic patients who are undergoing mercurial treatment.

It is characterized by the development of spongy, swollen gums of a bluish colour ; the alveolar margin of the jaws may undergo necrosis in bad cases. There is profuse salivation, and the breath has a characteristic and offensive smell.

(*f*) **Gangrenous (Cancrum Oris).**—This has already been referred to under Gangrene.

Treatment.—This consists in removing any ascertainable cause, giving tonics and good food, semifluid at first, and using an antiseptic mouth-wash, such as boric acid and glycerine, chlorate of potash, or peroxide of hydrogen. Ulcers should be touched with pure carbolic acid or nitrate of silver.

Tumours.—**Epithelioma** may be met with in the hard palate as the result of irritation, or in the mucous membrane of the floor of the mouth, whence it may spread to the lower jaw or to the tongue.

Syphilitic Gumma may occur as a round-shaped chronic swelling in the hard palate, as a rule near its posterior edge. Perforation of the palate is often brought about by the softening of the gumma and the separation of a sequestrum.

Tuberculous Disease of the mouth may occur as a secondary condition in pulmonary tuberculosis, or more frequently in the form of lupus spreading from the lips or nose.

Various other tumours, as dermoids, adenomata, lipomata, fibromata, endotheliomata, and cysts, may be met with in this situation. Endothelioma occurs in young subjects, and grows in the submucous tissue of the soft palate.

THE JAWS.

Many of the septic affections of the gums and jaws which are met with are directly or indirectly due to caries of the teeth. When this attacks the enamel of the tooth, it spreads through it by a process of disintegration till the pulp is reached. This becomes infected, and acute inflammation sets up, with development of pus, associated with more or less severe pain. The infection frequently spreads to the alveolar dental periosteum, and sets up what is termed **Periodontitis,** which is frequently followed by the development of an **Alveolar Abscess.** The pus forming at the root of the tooth frequently finds its way through the bone to the gums, and constitutes a **Gumboil.** Subsequently, if unreleased, the pus may make its way through the gum, or may burrow under the periosteum of the jaw and lead to **Necrosis** of the bone. Secondary effects of disease of the teeth are **Cellulitis** of the neck and engagement of the cervical lymphatic glands. Small **Cysts** are sometimes found at the roots of decayed teeth, and are probably part of the enamel organ which has taken on such growth owing to the septic processes in the pulp.

Treatment.—In dealing with accumulations of pus from dental caries, an external incision should be avoided where possible. When the pus is confined to the socket of the tooth, even if it has burrowed down into the bone, it is sufficient to extract the tooth. This will relieve the symptoms even in those cases where the pus has so burrowed as to distend the bone and form a hard swelling, felt on the outside of the jaw, and liable to be confused with some growth or chronic inflammatory trouble of the bone itself. The swelling is, of course, formed by the abscess, which is walled over by the bone of the jaw.

When the pus has burst through the socket or is in the form of

an alveolar abscess, an incision should be made and free drainage established. If this is done within the mouth, it should be frequently washed out with an antiseptic lotion.

When necrosis takes place and a sequestrum forms, its separation is slow. In the lower jaw, before this occurs there has usually formed a new arch, and little deformity takes place. In separating the sequestrum the mucous membrane is incised, and the new sheath divided on its outer aspect. The cavity should subsequently be swabbed over with pure carbolic acid and packed with gauze. In the upper jaw no new bone is formed, and so considerable deformity results from sinking of the cheek after removal of part of the bone.

Pyorrhœa Alveolaris is a chronic form of inflammation of the gums (gingivitis), formed in association with the teeth and periosteum of the alveolar process. It is due to septic infection, and is accompanied by an accumulation of tartar between teeth and gums, and there may be a discharge of pus at the edge of the gums. As the process continues, the roots of the teeth may become exposed by atrophy of the gums and alveolus, the teeth become loose, and even drop out. To stop the disease powerful antiseptics must be used, applying them between the teeth and the gums, while the teeth should be cleansed by a soft brush used with an antiseptic wash. Ionization in some cases does good.

A milder form of **Gingivitis** occurs in conjunction with general stomatitis, especially that associated with scurvy and mercurial poisoning.

Phosphorous Necrosis.—This is sometimes called "phossy jaw." The lower jaw was very frequently attacked in workers in the match trade. In former years it was an excessively common complaint; it is now much rarer. The infection is sometimes conveyed through decayed teeth, at others directly to the bone of the jaw.

Symptoms.—These are more of a local than a general character. There is great pain, seldom relieved by the extraction of a decayed tooth. Periostitis leading to necrosis of the bone. Pus oozes into the mouth from the affected bone, and if swallowed may lead to general infection. The glands below the mouth are sometimes enlarged and tender. There is a peculiar pallor with yellow tinging of the skin. Albumin is found in the urine.

The *British Medical Journal* has the following interesting note in the issue of January 2, 1909, concerning Levai's observations of the phosphorus workers of Austria. From it it would seem that their condition is worse than that of workers in this country:

"Levai (*Pester Mediz. Chirurg. Presse*, September 6, 1908) states that, among 1,500 persons engaged in Austria in the manufacture of phosphorous matches, 250 cases of phosphorous necrosis occur yearly. This disease is not the effect of local irritation, nor does it find its entrance solely through the medium of decayed teeth. It occurs in workmen with perfect teeth, and in one case a regenerated maxilla containing no teeth was attacked. On the other hand, some workers with very defective teeth have worked for many years in a phosphorus manufactory without developing necrosis. Phosphorus attacks the organism as a whole, and affects other bones besides the jaw. A phosphorus worker of forty broke two ribs after an insignificant blow, and twice fractured his forearm. A forty-year-old packer broke her femur four times in three years. (None of these patients had syphilis.)

In eleven cases Levai examined histologically the removed bone, and in two cases chiselled portions of bone out of the sound maxillæ, and found that the endothelium of the bloodvessels of the bone is diseased in those who have worked for a long time with phosphorus. This makes the bones brittle, and, as thrombus formation readily occurs in diseased vessels, predisposes to necrosis. To cause such a predisposition, four or five years' systematic employment in a phosphorus-containing atmosphere is sufficient, and, once it exists, a worker cannot avoid his fate, even by giving up his injurious occupation."

Diagnosis.—While acute phosphorus-poisoning may simulate yellow atrophy of the liver, there is little difficulty in diagnosing the chronic variety as shown in phosphorous necrosis, especially when we know the person's occupation.

Treatment consists in similar local measures to those used for other forms of necrosis.

Tuberculous and Syphilitic Affections.—These are rare in the jaw. The latter disease may strongly simulate a new growth, especially when it occurs as a diffuse gummatous infiltration of the lower jaw, rendering the patient unable to open his mouth.

In two cases recently seen, osteosarcoma was strongly suspected, but the condition cleared up under large doses of iodide of potassium. This drug should always be given in such cases before attempting any operative procedure.

Actinomycosis.—The lower jaw is the favourite seat of the disease, the *Streptothrix actinomyces* probably gaining access through a decayed tooth. There is first pain and tenderness, perhaps referred to a tooth. After a week or two a swelling forms which cannot be separated from the jaw. Redness of the skin next appears, and suppuration follows; the skin gives way, forming sinuses leading to the bone, and discharging the characteristic "sulphur bodies." If these are not detected, the disease may easily be mistaken for tubercle, syphilis, or sarcoma.

Treatment consists in cutting or scraping away the diseased tissues and administering large doses of iodide of potassium.

Tumours of the Jaws—Epulis.—This is a growth springing from the periosteum of the alveolus, and is of the nature of a fibro-sarcoma. In many cases the fibrous element preponderates so much that the tumour resembles a fibroma, but it recurs after removal unless the bone from which the growth springs is also removed. In most cases the tumour is a myeloma, in others an osteosarcoma. It springs from a gap between two teeth, and, growing slowly, enters the mouth or inclines outwards towards the lip or cheek. In appearance it is a red, smooth, round tumour, sessile or pedunculated, and adherent to the jaw. As it grows larger, if subjected to much pressure, it may break down and ulcerate, when it must be distinguished from granulations forming about a carious tooth; in its various stages it may be mistaken for a polypus, epithelioma, or angioma.

Treatment.—Removal together with the portion of the alveolar process from which it grows; if this is done, there is little tendency to recur.

Sarcoma.—Most common in the upper jaw, where all varieties are met with.

Signs and Symptoms.—When the growth springs from the periosteum covering the front of the bone, the growth spreads towards the surface

and the mouth. The cheek early becomes invaded, but there is no bulging of eye or palate, and rarely is the antrum invaded, though it may be. In this form a swelling is seen at an early stage.

When originating from the antrum, that cavity becomes filled, and its walls are then bulged in all directions, and on pressure eggshell crackling is elicited. On transillumination the cavity shows dark. The growth frequently obstructs the nostril and the tear-duct. A sanious discharge may come from the nostril. The eyeball may protrude, the palate be depressed, and the cheek protruded. The tumour may attain considerable size before any deformity is noticed.

When the periosteum at the back of the bone is concerned in the early growth of the tumour, it spreads into the spheno-maxillary or the pterygo-maxillary fossa, and the eyeball is protruded, usually by pressure from behind. After some time a swelling may be noticed in the temporal region, or the antrum may be invaded, when the signs mentioned above will show themselves. In all cases there will be **pain,** more or less referred to the second division of the fifth nerve, and **hæmorrhage** from ulceration of the tumour.

In the lower jaw the periosteal variety is chiefly met with. It grows rapidly, with early involvement of the submaxillary and cervical glands.

Myeloma is fairly common in the lower jaw, but there is little or no malignancy shown. It develops in the centre, and expands the part of the bone where the growth occurs.

Carcinoma.—In the upper jaw columnar or squamous epithelioma are met with. The former originates in the glandular tissue of the mucous membrane of the antrum or nasal cavities, and grows rapidly; and the latter springs from the mucous membrane of the alveolus or palate, and spreads to surrounding parts.

In the lower jaw, cancer of the lip, tongue, or floor of the mouth, frequently spreads to the bone, so that epithelioma is a comparatively common disease in this region.

Treatment.—In malignant disease of the upper jaw, where it has not involved other structures, the entire bone should be removed; if the growth has penetrated beyond the bone, operation should not be undertaken.

In the lower jaw, the lower border should be left if possible, if it is not done at the expense of leaving infected tissue. In many cases, however, the whole of one side has to be removed.

Simple Tumours are seldom met with. They comprise fibroma, chondroma, osteoma, either as a tumour composed of compact tissue or a diffuse osteoma (leontiasis ossea).

Arthritis of the temporo-maxillary joint may be—

(*a*) **Non-Suppurative.**—Due to rheumatism or gonorrhœa. There is pain, usually on both sides; the jaw is kept fixed because of this, with the mouth slightly open. There is effusion, and the swelling may be felt in front of the ear. Absorption may take place or fibrous ankylosis ensue.

The treatment is constitutional, and local to relieve pain and promote absorption.

(*b*) **Suppurative.**—This may develop as part of a general pyæmia,

or may spread from adjacent parts, as in middle-ear disease, etc. The signs are similar to those mentioned above, but there is more inflammation. The pus may come to the surface of the skin or point into the external auditory meatus.

Ankylosis usually results.

(*c*) **Tuberculous.**—Rare, but may occur as a primary affection, or, more commonly, as secondary to similar disease of the jaw, temporal bone, or middle ear. The local treatment is to incise and scrape away the diseased tissue, or to excise the condyle.

(*d*) **Arthritis Deformans.**—This is usually bilateral. At first the condyle is hypertrophied, the glenoid cavity being enlarged and flattened, and later it may be filled up with new bone. As the disease progresses, osteophytic outgrowths are formed round the joint, and lead to its fixation.

A protuberance is felt in front of the ear that corresponds to the enlarged condyle.

There is pain and creaking on moving the jaw, which is usually held depressed, with the chin shot forward. Treatment is not very satisfactory, and excision of the condyle may sometimes be called for. The disease is very chronic, but is liable to acute phases. In the later periods the condyle and glenoid cavity may become worn away.

Fixation of Jaw.—This may be **temporary** or **permanent.** The former is due to spasm of the masseter muscle from irritation caused by some neighbouring inflammatory condition, such as a carious tooth or unerupted wisdom-tooth. This is a frequent cause of parotitis or tonsillitis. The spasm passes off on removal of the cause.

Permanent fixation is due to the fibrous degeneration of muscle following at times on rheumatism and syphilitic myositis. More commonly it follows from cicatricial contraction, the result of burns or cancrum oris. It also follows injury to the jaw—fracture, dislocation, or arthritis. The ankylosis may only be fibrous or it may be osseous, and may be intra- or extra-articular. When the former, the best treatment is to resect the joint. When the latter, an artificial joint may be made by removing a wedge-shaped piece of bone from the ascending ramus.

THE TONGUE.

Wounds.—These are produced as a rule by biting with the teeth, as when a person receives a blow upon the chin. They are also produced by a foreign body being driven into the tongue. The immediate danger is hæmorrhage, especially when the posterior part of the tongue is injured. This is best met by applying adrenalin to the wound by means of cotton-wool wrapped round a probe, after which sutures should be inserted. Rapid healing is the rule, but may be interfered with by secondary hæmorrhage or by sepsis. To stop the first it may sometimes be necessary to ligature the lingual or even the external carotid artery. To obviate sepsis, the regular use of an antiseptic mouth-wash should be ordered.

Ulcers of the Tongue.—The most usual sources of ulceration of the tongue are irritation, as from a jagged tooth ; dyspepsia ; tubercle ; syphilis ; and epithelioma. Chronic irritative and syphilic ulcers, if untreated, may develop into epithelioma.

The following table shows the situation and characteristics of ulcers commonly met with in the tongue, together with their treatment :

Name.	Usual Situation.	Appearance.	Pain.	Treatment.
IRRITABLE	Opposite jagged tooth at edge of tongue	Ragged, irregular edges; sloughy, unindurated base	Painful	Removal of the source of irritation, when healing takes place rapidly. If it does not, suspect malignancy.
DYSPEPTIC	Dorsum, in middle or towards tip	Shallow, indolent ulcer without induration	Painful	Treat constitutional trouble, and paint ulcer with lunar caustic.
TUBERCULOUS ..	Tip of tongue	Shreddy edges, sinuous in outline; surface uneven, pale, and flabby, covered with yellow discharge. No induration. Surrounding parts swollen, and perhaps covered with tuberculous foci	Very painful	Excision under local anæsthetic, unless the patient is the subject of advanced pulmonary disease, when the surface should be dusted with orthoform and mouth washed with antiseptic lotion.
SYPHILITIC: (*a*) *Primary* ..	Side near tip	Not a great deal of induration, but much infiltration, enlargement, and tenderness of submaxillary lymphatic glands	Slight pain	Constitutional, and local application of black wash or lime-water after cleansing sore.
(*b*) *Secondary* ..	Edges and under-surface	Multiple shallow small ulcers; mucous patches; condyloma (Hutchinson's wart)	Painful	Paint with chromic acid (gr. x. to ℥i.).
(*c*) *Tertiary* ..	Dorsum, in centre or behind	Edges steep, ragged, and undermined; base unhealthy, with wash-leather slough; surrounding parts indurated	Quite painless	Constitutional, and local applications of black wash or chlorate of potash. If untreated, may develop malignancy.
EPITHELIOMA ..	Edges, at junction of middle and posterior third	Single. Edges hard, raised, and nodular; surrounding parts very hard. Glands enlarged	Painful	Early and free removal of affected segment and its lymphatic connections.

Glossitis—1. **Acute Parenchymatous** occurs in adult men as the result of cold, mercurialism, or debility, acting as predisposing causes, and usually due to streptococcal or staphylococcal infection as an exciting agent. There is rapid, painful swelling of the tongue, speech and swallowing are very difficult, and the swollen organ protrudes, rendering shutting of the mouth impossible. There is profuse salivation. The neck may become the site of cellulitis, and œdema of the glottis may occur.

Treatment.—Sharp purge, antiseptic mouth-wash, and leeches applied to the submaxillary region. When dysphagia and dyspnœa are marked, longitudinal incisions into the substance of the tongue relieve the congestion, or tracheotomy may be required. When sure of the infection, antistreptococcal serum may be employed.

2. **Acute Superficial.**—This may be (*a*) **simple**, due to dyspepsia; (*b*) **hemiglossitis,** of nervous origin and usually confined to the distribution of the lingual nerve; it is accompanied by herpes, and said to be analogous to herpes zoster. It is attended with high temperature and great pain.

3. **Chronic Superficial** (leucoplakia or leucokeratosis).—This variety is usually met with in males in the fifth decade. Syphilis, excessive smoking, drinking raw spirits, and eating hot, highly spiced foods, gout and rheumatism, all predispose to the condition.

The tongue is covered with white patches, the result of overgrowth and hardening of the superficial epithelium, which becomes thickened and raised above the surface, while simultaneously there occurs a small-celled infiltration of the submucous tissue. When the disease progresses beyond the mild type, there is dryness and hardness of the tongue, impairment of taste, and pain in chewing. The glands below the jaw are sometimes enlarged. Epithelioma may develop unless the disease can be cured, and this is difficult.

Treatment.—This consists in removing or obviating all sources of irritation, and employing a mouth-wash or antiseptic ointments; while some of the superficial epithelium may be removed by painting the patches with chromic acid, 10 grains to 1 ounce, or lactic acid, 20 per cent. solution.

Tumours.—**Epithelioma** has already been referred to under Ulcers of the Tongue. It usually occurs in males, in proportion of six to one female, between the ages of forty and sixty. Long-continued irritation is a powerful predisposing agent.

The disease as a rule occurs in the anterior half of the tongue, at the edge. It may occur as a warty growth or as an ulcer. When the disease spreads to the floor of the mouth, the tongue becomes fixed. As already pointed out, treatment is by free and early removal.

If inoperable, the pain should be relieved by cocaine and morphia; if bleeding occur, adrenalin should be used. If this fail, it may be necessary to ligature the lingual or external carotid artery. X rays or radium may be used as a palliative treatment, but they have little curative power.

Sarcoma.—This is very rare. In children occasionally the round-celled variety is met with.

The treatment is as above.

Innocent Tumours.—Lipoma, fibroma, and angioma, are occasionally met with, but are rare.

Papilloma.—Pedunculated or sessile, is not uncommon. It should

be removed with a wedge-shaped piece of the tongue, as malignant disease is liable to supervene.

Dermoid Cyst.—Sometimes develops beneath the tongue in the middle line, projecting under the chin. It may be mistaken, if it bulges into the mouth, for a retention cyst of a salivary gland, but is distinguished by its central position, yellow colour, and opacity. It should be dissected out.

Hyoglossal Duct Tumours and Cysts.—These are met with at the back of the tongue, in the foramen cæcum, as red, vascular tumours the size of a pea to a cherry, and in the tongue substance near the hyoid bone, where they form cysts, lined with ciliated epithelium, which contain mucus. They should be excised.

Congenital Malformation.—Absence of tongue. Arrested development : Both of these are very rare.

Bifid or split tongue : This condition should be remedied by paring and suturing the two sides together.

Tongue-Tie (Ankyloglossia).—Owing to the shortness of the frenum sucking is difficult, and, if not treated, speaking is interfered with. It is not a very common deformity, and incision of the frenum in normal cases may lead to hæmorrhage, ulceration, and tongue-swallowing. Where tongue-tie exists, a flat director having a slit to receive the frenum is placed beneath the tongue, and the edge of the frenum snipped with scissors.

Tongue-Swallowing.—Too great mobility of the organ from excessive length of the frenum allows it to fall back, and may lead to suffocation.

Nervous Affections of the Tongue.—**Neuralgia** of the lingual nerve is sometimes met with. If not relieved by medical treatment, it may be necessary to resect the nerve.

Spasm sometimes follows trauma implicating the hypoglossal nerve, or as a reflex affection in inflammatory conditions of the teeth and gums, or as a symptom of central nerve disease.

Paralysis may be due to disease of the nerve centres of the hypoglossal nerve or to trauma affecting the trunk.

There remains to be noticed a curious affection, probably of rheumatic or gouty origin, which is evidenced by a severe aching pain in the region of the foliate papillæ at the edge of the tongue in front of the anterior pillar of the fauces, and a prominence and redness of the papillæ which simulate an early stage of epithelioma. The diagnosis is made clear by examining the other side of the tongue, which shows a similar condition to be present. As the patient is usually a neurotic female, it is specially important to point out that the condition is not due to cancer. Anti-rheumatic treatment should be adopted, and, if the pain is severe, cocaine applied locally. It is sometimes well to give bromide of potassium on account of the " nerves " of the patient.

SALIVARY GLANDS.

Infective Conditions—Epidemic Parotitis (Mumps).—A parenchymatous inflammation of both glands, which do not suppurate.

Metastatic inflammation may occur in the testis, breast, or ovary.

Acute Parotitis.—Due as a rule to infection from a septic condition of the mouth being conveyed along Stensen's duct. It also follows

abdominal operations when feeding by the mouth is stopped, and is then held to be due to absorption from a septic mouth by a gland whose natural function is in abeyance, and so the outward flow of saliva is interfered with. The condition is also secondary to septic fevers where the blood is charged with pyogenic bacteria, as in diphtheria, typhoid, scarlet fever, measles, etc., and to extension of a suppurative process from the temporo-maxillary joint.

The gland is swollen, hard, and tender, there is constant dull pain ; later there is redness, œdema and fluctuation. At the end of three or four days there is usually suppuration, the pus being contained in numerous foci throughout the gland. Owing to its dense capsule, the pus may not come to the surface, but burrow among the tissues of the neck, and at times this gives rise to dyspnœa and dysphagia. This is one of the conditions which may be responsible for retropharyngeal abscess.

Treatment.—First by fomentation; when fluctuation appears an incision should be made parallel to the zygoma, in order to avoid injury to the facial nerve, and the rest of the operation performed by Hilton's method ; the septa should be broken down and thorough drainage insured.

The **Sublingual** and **Submaxillary Glands** may be affected in the same way, and occasionally at the same time as the parotid.

Ludwig's Angina.—This is an acute phlegmonous periadenitis of the cellular tissue around the **submaxillary** gland, usually caused by a septic infection from the mouth. The onset is sudden and acute, marked by a rigor, high temperature, and rapid, intermittent, low-pressure pulse. The submaxillary region becomes brawny, the swelling extends up towards the root of the tongue, and down through the cellular planes of the neck towards the mediastinum. The mouth is closed, tongue fixed, and swallowing not possible. Suppuration, with sloughing of the cellular tissue, usually occurs, and may lead to pyæmia.

Treatment.—Fomentations for twenty-four hours, then incisions through the deep fascia to relieve tension and liberate pus. Stimulating slop diet by the mouth or by the rectum, if necessary, should subsequently be given.

Tuberculous Disease.—This is rare as a primary affection of the salivary glands, but may be met with as a secondary condition to disease of the lymphatic glands within their capsule, from whence it spreads to the salivary gland tissue.

Salivary Calculus.—This is most common in Wharton's duct and the submaxillary gland, and least common in Stensen's duct. It occurs as a hard swelling in the floor of the mouth, which should be distinguished from early epithelioma. The calculi are formed of phosphate and carbonate of lime and some organic matter, and are caused by the action of bacteria on the saliva. In some cases a small foreign body may form the nucleus.

The **Treatment** is, to make an incision in the mucous membrane over the site of the calculus and remove it.

Salivary Obstruction.—This may be due to complete obstruction of the duct by a calculus, to injury or cicatrization following injury, or

to inflammation. It is most common in the submaxillary gland. There is painful swelling of the gland after food has been taken.

If the obstruction cannot be removed, it may be necessary to remove the gland.

Salivary Fistula.—This may occur in connection with either the parotid gland or Stensen's duct. In the former case it follows suppuration of the gland, especially that occurring round concretions; in the latter, it follows operation wounds or injury.

Treatment.—When in connection with the gland, the fistula frequently heals up; if it does not, the edges should be pared and brought together. When in connection with the duct, the opening may be closed with collodion applied externally, by cauterization, or by sutures; or a drainage-tube may be passed from the enlarged intrabuccal opening of the duct to the fistula. Treatment of the condition is difficult.

Tumours—Retention Cyst (Ranula).—Common in the sublingual gland. The result of cystic degeneration; it contains a thick, glairy fluid, and occurs as a round, smooth, bluish swelling on the floor of the mouth.

Treatment.—Make an incision through the mucous membrane, and try to dissect out the cyst. If this is impossible, the part left should be swabbed with chloride of zinc (gr. xl. to ℥i.).

Simple Tumours.—Most commonly met with in the parotid as a mixed tumour, and now regarded as an **endothelioma.** It contains cartilage as a matrix, and with this are portions of myxomatous, sarcomatous, and angiomatous growth, the proportions differing in various tumours. It is usually encapsuled, and gradually presses the gland tissue out of existence. The tumour usually appears in the third decade, is of slow growth, and forms a round tumour of varying consistency. The skin usually remains normal.

The tumour should be shelled out of the gland, avoiding the facial nerve and Stensen's duct. If left indefinitely, the growth may take on a malignant character.

Malignant Tumours.—These are rare unless as secondary to endothelioma. When present they have a high degree of malignancy. There is early involvement of the facial nerve. They should be removed as widely and as soon as possible.

Injuries of the Salivary Glands.—These are usually concerned with the parotid gland and its duct. The former is frequently injured during operations, its bloodvessels when injured giving rise to free hæmorrhage. The nerves passing through it are the facial and auriculotemporal, and if injured, paralysis of the part supplied will be caused. If the duct be injured, a salivary fistula frequently results; a cyst may form externally, when the fistula heals rapidly.

CHAPTER XXII

SURGERY OF THE SPECIAL SENSES: AFFECTIONS OF THE EYE, EAR, NOSE, AND THROAT

The eye: The eyelids, lacrymal apparatus, conjunctiva, cornea, sclera, iris, glaucoma, the lens, vitreous, retina, choroid, optic nerve, errors of refraction, ocular muscles, field of vision, the orbit, injuries to the eye, sympathetic ophthalmia.
The ear: General considerations and examination, the auricle, external meatus. Middle ear: Catarrhal and suppurative inflammation, complications. Internal ear and nerve: Injuries.
The nose and throat: The nose: Rhinitis, polypus, malignant growths, foreign bodies, epistaxis, the septum, accessory sinuses — The naso-pharynx and pharynx: Adenoid vegetations, ulcers, paralysis of the palate, tonsils, uvula— The larynx: Laryngitis, diphtheria, neoplasms, paralysis.

THE EYELIDS.

THE skin of the eyelids is loose, thin, and free from fat. The lids are stiffened by the so-called "tarsal cartilage," really a dense mass of connective tissue binding together muscles, glands, vessels, and nerves. The lids are lined with mucous membrane—the conjunctiva, which also covers the edges of the lids, extending as far as the cilia on the outer border of the edge. The Meibomian glands open at the edge, their secretion keeping it oily, thus preventing the tears from overflowing.

The skin of the lids is subject to most forms of dermatitis.

Blepharitis (Ophthalmia Tarsi, or Tinea Tarsi).—This is a chronic disease affecting the margins of the lids, and is characterized by an eczematous eruption and the formation of yellow crusts, matting the cilia into bunches. There may be actual ulcers, or merely a dry scaly condition of the lid margin.

Causes.—It is generally constitutional, encouraged by dirt. It is seen most often in children enfeebled by tuberculosis, etc. Slight but very chronic cases are often associated with eyestrain from errors of of refraction, therefore the vision should be examined in all cases. Staphylococci or streptococci are the most common organisms found in the discharge.

Consequences.—The cilia are in time either partly or entirely destroyed, or may grow irregularly (trichiasis), rubbing on the cornea and causing inflammation of that membrane (keratitis).

Treatment must be prolonged. Locally cleansing with a weak alkaline lotion, mercurial ointment (yellow oxide of mercury, gr. vi. to ʒi.) being rubbed on afterwards twice daily. General constitutional treatment must be attended to, and in slight but chronic cases errors of refraction must be corrected.

Hordeolum (stye) is an acute inflammation of a sebaceous gland at the root of a cilium. It is a small red swelling, pointing at the edge of the lid, often very painful, and tending to recur.

Causes.—It is generally caused by staphylococci. Anæmia, general weakness, sexual disturbances and eyestrain are predisposing causes.

Treatment.—Hot lotions are used to relieve the pain and hasten the formation of pus. When the stye points, it should be pricked with a needle. Staphylococcus vaccine, by hypodermic injection, and diluted ung. hyd. nit. dil. (1 in 7 of vaseline) locally, should be used for some time to prevent recurrence.

Chalazion (tarsal or Meibomian cyst) is a chronic inflammation affecting a Meibomian gland, causing a small swelling like a pea in the

FIG. 49.—TARSAL (MEIBOMIAN) CYST: RIGHT UPPER EYELID.

The Meibomian glands being embedded in the tarsal plate, the cyst presents both on the conjunctival surface and towards the skin.

(Mayou, "Diseases of the Eye.")

lid; it is not painful unless suppuration takes place in it. They are often multiple, and are commonest in young adults.

Causes.—It is probably due to a local inflammation in the gland, generally caused by the staphylococcus, followed by retention of secretion.

Treatment.—Remove by opening with a sharp scalpel, after the use of cocaine and adrenalin to the conjunctiva, taking care to scrape away the sac wall with a sharp spoon, or it will soon fill up again. Staphylococcus vaccine should be given if a fresh chalazion form.

Ptosis (drooping of the upper lid) may be congenital or acquired, complete or partial, and may affect one or both sides. Congenital

ptosis is usually bilateral, and is due to weakness or absence of the levator palpebræ superioris muscle. Acquired ptosis is due to paralysis of the same muscle, generally on one side only. The other muscles supplied by the third nerve may be paralyzed at the same time. Diseases of the conjunctiva, such as trachoma, may also cause ptosis.

Treatment.—If a cause for the paralysis, such as syphilis or rheumatism, can be found, it must be treated. Congenital and traumatic cases may be operated upon, the usual operations depending on the use of the frontalis muscle, either by forming cicatrices or by shortening the tendon of the levator. The result may be an improvement, but it is seldom quite satisfactory.

Entropion is a turning in of the lid margin, causing the cilia to rub against the cornea.

Causes.—It may be either muscular or organic. The former is due to spasm of the orbicularis from reflex irritation, or in old people from prolonged bandaging, and affects the lower lid only. Organic entropion affects either lid, but specially the upper, and arises from any cause altering the structure of the lid, the most common being cicatrices in the conjunctiva from trachoma (*vide infra*) or following burns.

Treatment.—If muscular, remove the cause, and use strips of plaster or contractile collodion on the skin to pull the lid outwards. Organic entropion requires operation, the object being to remove the cilia from contact with the conjunctiva, and direct them outwards.

Ectropion.—A turning out of the lid margin. Causes either muscular or organic. Muscular ectropion is commonest in old people, arising from laxity of the muscles, so that the lid falls away from the globe. It sometimes follows prolonged bandaging, and is very unsightly. As the canaliculi are displaced, the drainage of tears is interfered with. Organic ectropion is cicatricial, arising from burns, wounds, etc., of lids or skin of face. The eye, being unprotected, often suffers.

Treatment.—Slit the canaliculus to relieve epiphora (overflow of tears). Treat the conjunctivitis with astringent lotions, such as zinc. sulph. (gr. ii. to ʒi.), or in severe cases cauterize the conjunctiva to cause it to contract. In organic cases a plastic operation may be necessary.

Distichiasis and Trichiasis.—These two diseases are often confused. The former is the growth of two rows of cilia in place of one, and is congenital; the latter is an irregular growth of cilia resulting from inflammation at their roots, so that they rub on the cornea and cause keratitis. The latter is treated by removal of the cilia, either by epilation (temporary only), electrolysis of their roots, or a plastic operation, as for entropion.

Lagophthalmos is the name given to imperfect closure of the lids, as is seen in various affections causing proptosis, or pushing forward of the globe. If persistent, it may lead to ulceration of the cornea from exposure.

Symblepharon is the adhesion of the lid to the globe as the result of a burn causing two raw surfaces to be opposed to one another.

Ankyloblepharon is the adhesion of the two lid margins from a similar cause.

Abscess of the lids is generally traumatic, but is occasionally seen in delicate children without a history of injury. Often what appears to be an abscess in the lid is really due to pus finding its way to the surface from disease in the orbit or from the nasal cavities.

Abscess is treated by opening and draining as in other situations.

Neoplasms.—Warts sometimes occur on the lids, and may grow to a great length.

Sarcoma is a rare growth on the lids, but both pigmented and non-pigmented are occasionally seen.

Epithelioma is a common growth on the lids, generally at the inner angle. It begins as a flat, wart-like elevation, with a brownish crust on its surface. It is an extremely slow growth, not generally involving the glands.

Rodent Ulcer is cancer of the glands of the skin, and does not give rise to secondary growths; it spreads slowly, destroying everything in its course. It may be confused with lupus or syphilis. Lupus generally begins before puberty; syphilis shows other symptoms. The treatment is by the application of radium in the early stages of the disease, but if the orbit is seriously involved, excision may be necessary.

LACRYMAL APPARATUS.

The **Lacrymal Gland** suffers from acute and chronic inflammation, but both are rare, the former being more common in children. Occasionally the acute form is seen in an epidemic of mumps. In both forms there is a very tender swelling in the outer part of the upper lid, pushing the eye downwards, with a characteristic triangular patch of chemois of the ocular conjunctiva. The acute form is treated with leeches, purgatives, warm fomentations, and incision; the chronic with mercurial ointments. Cysts (dacryops), tumours (endothelioma, mixed cell tumours) also occur, and should be excised.

Dacryocystitis.—Inflammation of the lacrymal sac may be acute or chronic, the latter generally preceding the former, following obstruction to the nasal duct. Once the duct is stopped, mucus, débris and organisms collect, distending the sac and setting up a chronic inflammation. This may show externally as a little lump like a pea under the skin just below the inner canthus, which disappears on

Fig. 50.—Canaliculus Dilator.
(Mayou, "Diseases of the Eye.")

pressure, with regurgitation of mucus or muco-pus into the eye. This is known as "mucocele," and it may last for years, or may lead at any time to **Acute Dacryocystitis,** due to infection of the cellular tissue around the sac. The latter comes on with great swelling and intense pain, and generally fever. The eyelids are closed by the swelling, and an abscess forms and points over the region of the sac. This generally subsides in a few weeks, but sometimes a lacrymal fistula is left.

Treatment.—Cure the stenosis of the sac if possible. The sac should be syringed with an antiseptic lotion, when, if this lotion goes through to the nostril, a cure can generally be attained. Probes are not used so freely now as they used to be, as the passage made by them is apt to close again. If the stenosis resists treatment, or if a fistula has

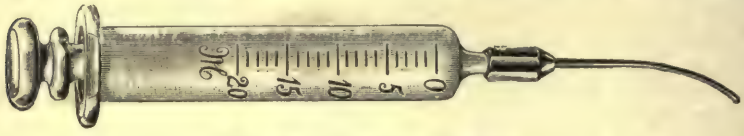


FIG. 51.—LACRYMAL SYRINGE.
(Mayou, "Diseases of the Eye.")

formed, the sac may be excised or an opening made from the nose into the sac (West's operation). The acute form should be treated with hot fomentations and purgatives; if an abscess forms it should be opened and drained.

THE CONJUNCTIVA.

The **Normal Conjunctiva** is comparatively sterile in clean persons, while in dirty persons various organisms are found in the conjunctival sac. The tears have little if any bactericidal power, and act chiefly by washing the conjunctiva. In practice this is found to be the best method of cleansing it before operation—to douche it freely with a warm sterile fluid, such as normal saline, for several days, and to wipe out the fornices with wool.

Hyperæmia of the Conjunctiva, if acute, may be the first stage of conjunctivitis or of iritis. Examine the pupil for the latter. There may be a minute foreign body in the cornea, which is only seen by focal illumination, or under the upper lid.

Chronic Hyperæmia is generally passive congestion, affecting the conjunctiva of the lids more than that of the globe, and causing a feeling of burning, heaviness, or irritation. It is most often caused by eyestrain from errors of refraction. Remove the cause if possible, and do not use astringents.

Conjunctivitis.—Many varieties are described, and, as they run into each other, classification is difficult. The following is perhaps as useful as any :

1. Simple or catarrhal conjunctivitis : (*a*) Chronic ; (*b*) acute ; (*c*) follicular.
2. Purulent conjunctivitis (including ophthalmia neonatorum).
3. Membranous conjunctivitis : (*a*) Croupous ; (*b*) diphtheritic.
4. Granular conjunctivitis (trachoma).

1. (*a*) **Chronic Conjunctivitis.**—This is often just an advanced form of hyperæmia, caused by eyestrain, in which case it may last for years with little change. It may follow an acute attack, when some organism may be found in the secretion.

Chronic conjunctivitis affects chiefly the palpebral conjunctiva. The patient complains of a feeling of grit or sand in the eye, heavi-

ness of the lids, burning sensations, etc. On inspection the conjunctiva of the lids is seen to be red or congested, and a little secretion is seen at the edges or angles—just sufficient to make the lids stick together in the mornings.

Treatment.—If there be any error of refraction, correct it. Order a mild astringent lotion, and brush the lids two or three times a week with 10 per cent. solution of protargol.

1. (*b*) **Acute Conjunctivitis,** or **Catarrh,** is characterized by marked hyperæmia and swelling of the conjunctiva, with sticky secretion. Generally the whole membrane is affected, but in slight cases it may be that of the lids only. The secretion varies from mucous to mucopurulent, mixed with abundant tears. Generally both eyes are affected, and often several members of a family, or it occurs in epidemic form in schools or institutions.

Fig. 52.—Diplobacilli from a Case of Angular Conjunctivitis.
(Mayou, "Diseases of the Eye.")

Causes.—It is seldom, if ever, due to cold, as is popularly supposed, but to infection. The cause is the Morax-Axenfeld diplobacillus, but various organisms, such as staphylococci, may be associated with it.

Symptoms.—Hyperæmia at first, lasting from a few hours to one or two days; then watery discharge followed by a sticky secretion with red angles to the eyelids (angular conjunctivitis). There is no swelling of the lids, and may be pain in the eye. Photophobia is not marked unless the cornea is also affected.

The **Diagnosis** is from *Purulent Conjunctivitis*, *Iritis*, and *Glaucoma*. In *Purulent Conjunctivitis* the symptoms are all more severe, the swelling greater, and the lids tense and brawny at first. When the secretion appears, it is not merely muco-pus, but true pus, generally very abundant. In *Iritis* there is no sticky secretion; pain is a marked symptom as a rule, running down the side of the nose and over the forehead. The iris is discoloured; the pupil is contracted, and does not react well. In acute *Glaucoma* there is severe pain in the brow, no secretion, the pupil is dilated, and there is loss of sight, often complete.

Treatment.—Order a lotion containing zinc sulphate (gr. i. ad ℥i.), with boric acid (gr. x. to ℥i.), to use freely for cleansing the eye, and a simple ointment to prevent the lids sticking together. In severe cases brush the conjunctiva of the lids three times a week with protargol 10 per cent. If pain is severe, iced compresses may relieve it in the early stage, and hot fomentations later. Remember that the affection does not tend to disappear if left alone.

1. (*c*) **Follicular Conjunctivitis** is a conjunctivitis, either acute or chronic, followed by the appearance of rows of small follicles or granules on the conjunctiva, chiefly of the lower lid. They are the normal adenoid tissue of the part hypertrophied, and disappear without leaving any traces, in which they differ from the granules of trachoma (*vide infra*).

When follicles are seen, the case may be expected to be tedious. It is specially liable to occur in epidemics in schools.

Fig. 53.—Follicular Formations in the Lower Fornix—So-called "Follicular Conjunctivitis."

(Mayou, "Diseases of the Eye.")

Treatment is the same as for acute conjunctivitis, but more vigorous, rather stronger astringents being used. If it is very obstinate, the everted lids may be rubbed with a stick of sulphate of copper once or twice a week.

2. **Purulent Conjunctivitis (Acute Blenorrhœa, Purulent Ophthalmia).**—This is the cause of about a third of the blindness in the world, so is of great importance. It is essentially infectious, the most important cause being the gonococcus, though other organisms may cause it also, as the Koch-Weeks bacillus, pneumococcus, streptococcus, etc. The two forms in which it occurs are so different that they are best considered separately.

(*a*) **Ophthalmia Neonatorum** is a form occurring, as its name implies, in new-born children, due to infection at or soon after birth, which with proper care is largely preventable. It is a notifiable disease under the Infectious Diseases Act.

Cause.—Infection by vaginal discharge either before or at birth, or subsequently by fingers or cloths. Two-thirds of the cases, including nearly all the worst ones, are due to gonococcus; other organisms

cause the other third. These other organisms may be any of those associated with acute conjunctivitis.

Course.—The symptoms appear one to three days after infection. For one or two days the lids are greatly swollen and opened with difficulty, and a thin watery discharge comes from under them. Generally both eyes are affected. In the second stage the lids soften, and can be opened better. The conjunctiva is seen to be chemosed, often so much so that it bulges over the corneal margin. There is a free flow of pus. This stage lasts about six weeks, the pus continuing to come after all swelling has disappeared. As a rule, the earlier the case begins, the more severe it is. At any time, but oftenest in the early stages, the cornea may be infected. It becomes grey, then yellow, and sloughs, either in part or entirely, with destruction of sight. Or a corneal ulcer may form, which may heal and leave a scar, with more or less interference with vision, according to its size and position.

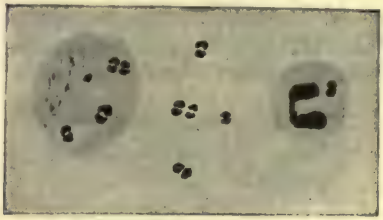


FIG. 54.—GONOCOCCI IN THE DISCHARGE FROM A CASE OF OPHTHALMIA NEONATORUM. (Mayou, "Diseases of the Eye.")

Prevention.—Prevention is possible, as shown by results of prophylactic treatment in large maternity hospitals. In ordinary routine great cleanliness only is required, but where there is any vaginal discharge in a mother a drop of 1 per cent. solution of silver nitrate should be dropped into each eye after the baby is washed.

Treatment.—At the slightest sign of swelling or discharge the baby's eyes should be treated at once. They should be cleansed every two hours with a mild antiseptic lotion, and, when pus appears, the conjunctiva of the everted lids should be brushed daily with silver nitrate solution, the rule being that the freer the secretion, the stronger may be the caustic. Generally a solution of 5 to 10 grains to 1 ounce is used. Warning should be given that the discharge is very infectious, and all wipes, etc., used should be burned at once.

(*b*) **Purulent Ophthalmia** occurs in adults, due to the same organisms as in infants, but the course is rather different. In gonorrhœal infection it is sometimes carried on the hands from the genitals, and is the most dangerous form, often destroying vision in spite of treatment. In the first stage the swollen lids are as hard as boards, and when they open the chemosis of the conjunctiva is very great, and the cornea may be already opaque and sloughing. This early sloughing is due to swelling of the conjunctiva round it, and the collection of purulent matter in the fold at the limbus. Later there may be ulceration or sloughing from direct infection of the cornea by the gonococcus, as in ophthalmia neonatorum, and if this occurs it generally is so

severe as to lead to blindness. A less acute form due to the Koch-Weeks bacillus is very common in children, and is usually not severe but very infectious, and is the cause of "pink eye" epidemics in schools.

Treatment.—The same as in ophthalmia neonatorum, with the addition of a shield over the sound eye (Buller's shield), if one eye only is affected, to preserve the sound one from infection. To relieve the great chemosis of the conjunctiva, free radial incisions may be made in it, and bleeding encouraged by hot douches. If there is much pain, leeches may be applied near the angles of the lids. In mild cases 10 per cent. protargol should be applied to the conjunctiva.

3. **Membranous Conjunctivitis** includes **Croupous** and **Diphtheritic.** Practically this is purulent conjunctivitis beginning with the formation of a membrane on the conjunctiva of the lids. The first stage, with hard swelling of the lids, may last as long as six days. In some cases the membrane peels off, but in others, more severe, it sloughs, leaving a raw surface which may eventually cause entropion. In bad cases the cornea may be destroyed. The general symptoms are sometimes as severe as in diphtheria of the fauces. Such cases are rare in this country, but more common in Germany.

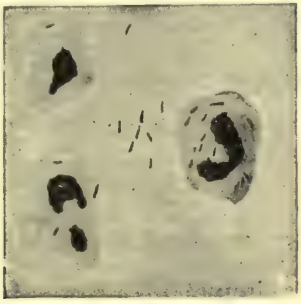


FIG. 55.—KOCH-WEEKS BACILLUS.
The commonest cause of purulent ophthalmia.
(Mayou, "Diseases of the Eye.")

Cause.—The diphtheria bacillus is found in some cases, generally the more severe, while in others streptococci, pneumococci, and *B. coli*, are found.

Treatment is at first the same as in purulent conjunctivitis. When membrane is seen, it should be examined for the diphtheria bacillus. If this is found, or if the examination is not possible and the general symptoms are severe, antitoxin should be used at once. In any case, if a membrane is seen, strong astringents should be avoided, and the patient should be isolated. If the cornea is affected, hot douches and atropine drops should be used.

4. **Trachoma.**—This is very important on account of its widespread distribution and serious effects. In countries where it is common, as in Egypt and Russia, it accounts for 50 per cent. of the cases of blindness. In its early stage it is not distinct from other forms of conjunctivitis, and may appear merely as a congestion of the conjunctiva, or as a catarrh or a mild purulent conjunctivitis, the follicles developing later.

The follicles are small, opaque, yellowish-grey, 1 or 2 millimetres in diameter, embedded in the conjunctiva, but rising above its surface; they have been likened to sago grains or frog spawn. They occur most frequently in the upper lid and fornix. They are distinguished from simple follicles by the following points :

(*a*) The follicles in follicular conjunctivitis are smaller, mostly in the lower lid, and lie more or less in rows ; in trachoma they are larger, less well defined, tend to become confluent, and mostly in the upper lid.

(*b*) Follicles cause no change in the structure of the conjunctiva ; trachoma leads to scarring.

(*c*) In follicular conjunctivitis the general surface of the conjunctiva remains more or less normal, while in trachoma the conjunctiva of the upper lid becomes soft and velvety, due to hypertrophy of the normal papillæ.

(*d*) Follicles disappear spontaneously, leaving no scar; while granules last for years, always leaving cicatrices behind, with a tendency to contract.

(*e*) There is slight ptosis (drooping of the lid) with trachoma, none in follicular conjunctivitis.

(*f*) The cornea is affected either with ulceration or pannus (*vide infra*) in 25 per cent. of the cases of trachoma, and not at all in simple follicular formation.

(*g*) Follicular conjunctivitis is a disease of childhood and youth; trachoma may occur at any age.

When the cornea is involved, the symptoms are much more marked, specially pain and photophobia. **Pannus** is the commonest corneal complication, and is a form of inflammation affecting the superficial layers of the upper half of the cornea, where it is rubbed and infected by the scarred and rough upper lid. As cicatrices form and contract, the edge of the lid turns in (entropion), and the cilia rubbing on the cornea greatly aggravates matters.

Cause.—A specific micro-organism probably exists, but has not been certainly demonstrated yet. The disease is contagious, though not so highly so as used to be thought. It is essentially a disease of filth, poverty, and overcrowding, though it is also seen that some races are more liable to it than others. Jews and Irish are specially prone to attacks, whereas Highland crofters and American negroes, who live in no better conditions, are exempt.

Treatment.—If seen in the early stage, when the granules are separate and distinct, surgical treatment is effectual, the granules being squeezed out. In the later stage a stick of sulphate of copper rubbed on the everted lids once or twice a week is the most usual treatment, or the lids may be brushed with a 2 per cent. solution of hydrarg. perchlor. in glycerine, which is not painful. An antiseptic lotion should be ordered for home use, and general hygiene attended to.

Other Affections of the Conjunctiva.

Pterygium is a triangular fold of thickened and vascular conjunctiva running horizontally, with its base on the sclerotic and its apex on the cornea. It may progress slowly for years, but its removal is often called for on account of its appearance. It is probably caused by irritation, the lids not meeting closely when closed. Astringent lotions may be tried when it is slight, but if it is large it must be dissected off.

Dermoid Tumours are rare and always congenital. They grow on the corneal margin, and may have hairs on them. They can be dissected off if unsightly.

Granulation Tumour is often seen after injury or operation. It is red, smooth, and soft, and bleeds easily. It should be snipped off, and the stump cauterized, if large.

FIG. 56.—TRACHOMA WITH PANNUS.
(Mayou, "Diseases of the Eye.")

Subconjunctival Ecchymosis occurs chiefly from injuries, but also as a result of pertussis, occasionally in conjunctivitis, and sometimes without apparent cause when the vessels are atheromatous. In

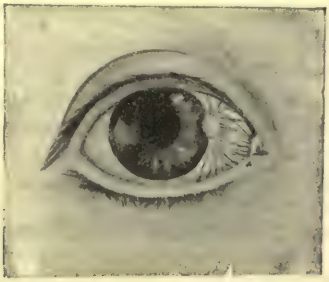


FIG. 57.—A PHLYCTENULE.
(Mayou, "Diseases of the Eye.")

fracture of the base of the skull, blood may appear under the conjunctiva, coming from the back of the eye forwards. No treatment is required for ordinary ecchymosis, the blood being absorbed in a few days.

Phlyctenular Ophthalmia (Phlyctenular Conjunctivitis and Keratitis; Conjunctivitis Lymphatica).—This is one of the commonest external diseases of the eye, and of great importance, as it affects so many children of the poorer classes. It does not often cause blindness, but it is accountable for an immense amount of defective sight. Small nodules of exudation like minute pimples occur on the conjunctiva

or cornea, most often just about the corneal margin, each one pointing and breaking down into a small ulcer. If on the conjunctiva, the membrane round the phlyctenule will be injected and red ; if on the cornea, there will be a little bundle of vessels running out to it. There may be only one phlyctenule or several, and sometimes there are a number of very minute ones close together just inside the corneal margin, and looking like sand grains on the surface—miliary phlyctenules. There is great variation in the severity of the symptoms, which do not at all correspond to the severity of the affection. Photophobia is generally present, and often intense, particularly in the miliary form. It is essentially a disease of childhood, and is seldom seen after puberty except as a recurrence of earlier attacks. It often lasts for months, recurring every winter ; and as each little ulcer on healing is liable to leave a small opacity behind it, the ultimate result is that the cornea becomes studded with small opacities, greatly reducing vision. It almost always affects both eyes, though not necessarily together.

Cause.—Is an infection of the deeper layers of the conjunctiva, frequently of staphylococcal origin. The affection is often seen after the exanthemata or some debilitating affection in childhood, and is always a sign of faulty nutrition. It is not necessarily due to underfeeding ; it is often seen in fat, flabby children who are eating all day long, and consequently never digesting their food properly.

Pathology.—The exudate is at first a solid mass of lymph cells between the corneal epithelium and the layer of Bowman; but when it breaks down into an ulcer, the surrounding tissues necrose, and the superficial layers of the cornea are affected. If this happens, a corneal opacity remains when the ulcer heals. There is generally a watery discharge, which may cause eczema on the face.

Treatment.—Regulate meal-hours and food, and attend to general hygiene. Syrup. ferri iodidi and cod-liver oil are useful. Local treatment will be guided by symptoms. A simple antiseptic lotion should always be used, and if there is much photophobia atropine drops (gr. ii. to ʒi.). If there is no ulceration, precipitated calomel may be dusted in twice a week, or ung. hyd. ox. flav. dii. used daily. The eyes should be shaded from bright light, but never bandaged or tied up. When there is a discharge from the nose, the adenoids should be removed if present. For the treatment of cornea opacities, if such result, *vide infra*.

THE CORNEA.

Keratitis (inflammation of the cornea) may be non-suppurative or suppurative, local or general. All forms disturb the transparency of the cornea, and if the part in front of the pupil happen to be affected, sight is interfered with. As the cornea is much exposed, and nourished by the infiltration of serum from its edges, and not by a direct blood-supply, it is prone to injury and disease. If injury or disease is suspected, the cornea must be examined by focal illumination—light coming from the side (best from a lamp or candle) being focussed on it by means of a lens. In this way defects in its transparency, in the lustre of its surface, and in its spherical shape, may be detected.

Suppurative Keratitis includes—(*a*) **Abscess,** (*b*) **Ulcer.**

(*a*) **Abscess of the Cornea** is a circumscribed infiltration of pus in the deeper layers of the cornea, generally accompanied by symptoms of violent irritation, ciliary injection, iritis, pus in the anterior chamber

(hypopyon), and probably pain. It is often due to the staphylococcus It generally opens on the surface eventually, forming a large sloughing ulcer. If seen early, atropine is used to allay the iritis, and the abscess is opened under antiseptic precautions. The pus is often sticky, and has to be removed with forceps.

Ulcer of the Cornea develops from the breaking down of an abscess or phlyctenule, from local infiltration or injury. Once an ulcer starts, it may spread, the tissues round becoming infiltrated and then necrosed. It may extend over much of the cornea, causing great destruction, followed by dense opacity causing blindness. Or it may extend more deeply till it perforates the cornea, and the aqueous escapes with a

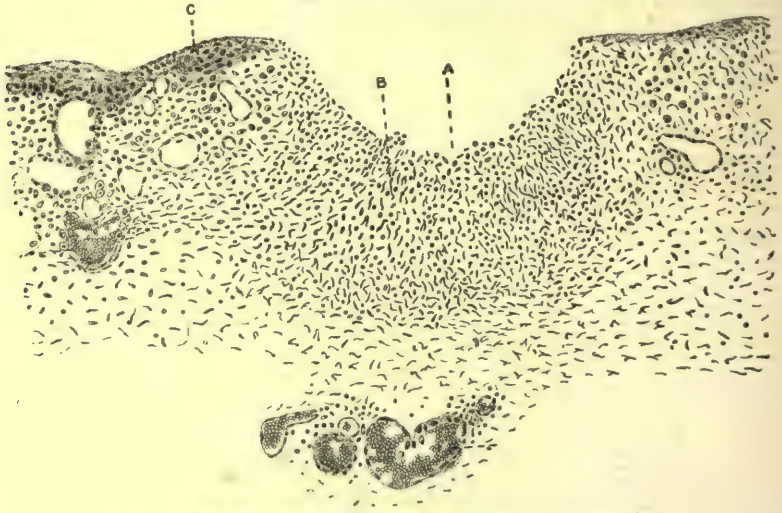


FIG. 58.—PHLYCTENULE AFTER RUPTURE.

A, Base of the ulcer; *B*, cellular exudation; *C*, epithelium.

(Mayou, "Diseases of the Eye.")

rush, carrying the iris into the perforation. When the ulcer heals, the prolapsed iris remains attached to the corneal scar; this is known as an *adherent leucoma*.

Cause.—In 95 per cent. the cause is the pneumococcus, often derived from the lacrymal sac.

Varieties.—Many varieties of ulcer are described; the following are the chief:

Progressive Ulcer is the ordinary ulcer in its acute stage, and is characterized by a rough, elevated edge surrounding the loss of substance. The floor of the ulcer is dull, and there is irritation, pain, photophobia, and in severe cases iritis.

Regressive Ulcer is the healing stage of the same. The acute symptoms are gone; the hollow is lined with new epithelium, and is no longer dull and dark; and if infiltration was present, it has disappeared.

Serpiginous Ulcer is not a common form. In it a wave of infiltration seems to flow across the cornea, followed by a hollow caused by

loss of the necrosed tissue. A track of opacity remains behind, doing great damage to the sight.

Marginal Ring-shaped Ulcer is also comparatively rare. It spreads like a snail-track round the margin of the cornea. There is not much infiltration, and it is only seen in a good light. Though it is shallow, there is great risk of interference with the nutrition of the cornea.

Hypopyon Ulcer is common and serious. The ulcer, which often arises from some slight injury in an old or enfeebled person, is generally large and deep, with much infiltration of the tissues round about it, and pus in the anterior chamber. This pus is sterile, and is due to the great irritation causing an output of leucocytes from the iris and ciliary body, which settle in the form of pus in the bottom of the anterior chamber. If the ulcer heals, the pus is generally quickly absorbed. In severe cases there is often great pain, iritis, and widespread sloughing of corneal tissue.

Causes.—Ulcers seldom arise except from injury or some antecedent affection, usually a phlyctenule or abscess. If the ulcer is small and shallow, there may be hardly perceptible suppuration, but in feeble or unhealthy persons a very slight injury may be followed by a large

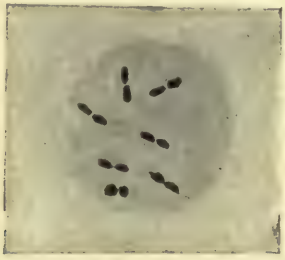


FIG. 59.—PNEUMOCOCCI FROM A SERPIGINOUS CORNEAL ULCER FOLLOWING LACRYMAL OBSTRUCTION.

(Mayou, "Diseases of the Eye.")

hypopyon ulcer, as noted above. Any virulent organism in the wound may also cause a destructive ulcer, as in purulent conjunctivitis. The amount of injury done will depend upon its virulence and the resisting powers of the cornea.

Prognosis.—If there is merely a superficial abrasion no opacity need follow, but if the corneal layers are affected there will be more or less opacity. If this is in front of the pupil, it will affect vision, and if dense it may destroy it. Some of the possible results of ulcer of the cornea are—

1. Healing with slight superficial opacity, called "nebula."
2. Healing with a well-marked small opacity, called "macula."
3. Healing with dense white opacity, covering a large area or even the whole of the cornea, called "leucoma."
4. Perforation of the cornea, with healing, the iris being tangled in the dense cicatrix, known as "adherent leucoma."
5. Healing followed by bulging of the corneal cicatrix, called "anterior staphyloma." The staphyloma is known as "total" or "partial," according as it includes the whole or a part of the cornea.
6. The ulcer may perforate the cornea, and, instead of being followed by healing, a general suppuration of the eyeball may come on, known

as "panophthalmitis." This ends by leaving the eye a withered stump, with, of course, total blindness.

Treatment.—The general health is the first, and sometimes the only, thing that needs attention. Rest, warmth, good food, and cleanliness, will often work wonders. Locally, strong astringents are to be avoided. The eye should be cleansed with a non-irritating antiseptic lotion, and atropine drops (gr. ii. to ʒi.) instilled twice daily, except in the case of deep marginal ulcers about to perforate, when eserine should be used to keep the iris away from the perforation as much as possible. If the eye is irritable it should be bandaged. If perforation occurs, try to replace the protrusion of the iris, snipping off a piece of it if necessary; but this should not be attempted unless the case is seen within a day or so of the perforation. If there is hypopyon (pus in the anterior chamber), use atropine at first, but if the pupil does not dilate stop it soon. If pus fills the anterior chamber to a third of its depth or more, it will not be absorbed, and must be evacuated by opening the anterior chamber. In large sloughing ulcers iodoform dusted on them is often a help to healing. In progressive ulcers with an infiltrated area at the margin, showing signs of spreading, that area should be cauterized or touched with pure carbolic. When all signs of irritation have disappeared, the opacity, if any,

FIG. 60.—DENDRITIC KERATITIS.

Appearance of the cornea after staining with fluorescin.

(Mayou, "Diseases of the Eye.")

must be treated; for though no treatment will remove a dense opacity, prolonged treatment may do a good deal towards clearing up lighter ones. Dionine (gr. x. to ʒi.) should be instilled once a week, or hydrarg. ox. flav. (gr. vi. to ʒi. of vaseline) rubbed into the cornea night and morning.

Such treatment must be kept up for some months. If there is a dense central leucoma and a clear margin of cornea, an iridectomy under the latter may restore some vision.

Neuroparalytic Keratitis is an ulcer associated with some lesion of the ophthalmic branch of the fifth nerve, its nucleus, or the Gasserian ganglion. Besides keratitis, there is anæsthesia of the cornea and the parts round the eye, lessened activity of the lacrymal gland, and often rapid destruction of the corneal tissue.

The cause is often obscure. It may arise from febrile disease, gout, rheumatism, syphilis, or carious teeth. The treatment will depend upon the cause, if found. The eye should be bandaged to protect the cornea.

Non-Suppurative Keratitis includes five chief forms of which two are superficial: pannus and herpes corneæ; and three deep: inter-

stitial keratitis, punctate keratitis, and sclerotizing opacity of the cornea.

Pannus arises in severe cases of trachoma. There is vascularity and opacity of the superficial layers of the upper half of the cornea due to infection with trachoma, caused by the rubbing against it of the hard scar tissue of the conjunctiva of the upper lid, and increased by the irritation of the inturned lashes where entropion has followed the trachoma.

The **Treatment** is that of trachoma, and the application of Jequiritol to the conjunctiva.

Herpes Corneæ often accompanies true herpes frontalis of the fifth nerve, when vesicles form on the cornea. These vesicles contain clear fluid, and are accompanied by neuralgic pain and photophobia. They soon burst, leaving superficial ulcers, which are very intractable in healing, and an interstitial opacity of the cornea may result.

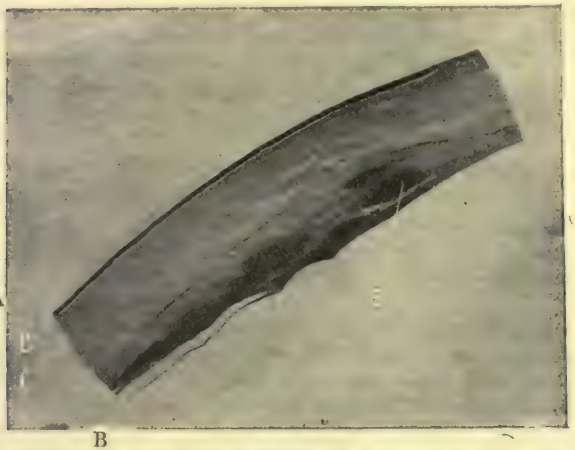


FIG. 61.—INTERSTITIAL KERATITIS.

A, Corneal epithelium; *B*, Bowman's membrane; *C*, substantia propria; *D*, Descemet's membrane; *E*, round-cell infiltration in the deeper layers of the cornea.

(Mayou, "Diseases of the Eye.")

Treatment.—Nourishing food is important, and large doses of sodium salicylate, and locally atropine drops and hot fomentations.

Interstitial Keratitis is a chronic affection, generally affecting both eyes, and occurring in children or young people. It is characterized by a cellular infiltration of the deeper layers of the cornea, not tending to ulceration, but accompanied by more or less inflammation of the uveal tract. It is analogous to disease of the fibrous tissue in other parts of the body, and is always constitutional, and in the great majority of cases is caused by inherited syphilis. Beginning as a grey patch on one side of the cornea, it spreads all over it in a few weeks, the surface becoming dull and the iris almost or quite lost to view. The second stage comes on in a few weeks, with vascularity and signs

of irritation—pain, photophobia, etc. Then the opacity begins to clear at the edge, and may eventually clear off entirely in a few months up to two years, or in severe cases some opacity may remain permanently.

Cause.—As noted above, it is always constitutional, and probably in over 95 per cent. of cases due to inherited syphilis. The remaining cases are due to tubercle.

Diagnosis rests on the slow onset and course, on the presence of ciliary injection, on the dull surface of the cornea (like glass that has been breathed upon), and on the age of the patient, generally from five to fifteen, and oftenest just approaching puberty. Other signs of congenital syphilis will often be found, especially irregular, notched teeth.

Treatment must be both local and constitutional. Local treatment will consist in weak atropine drops till all signs of irritation disappear, and hot fomentations to promote absorption of inflammatory products. As soon as the irritation disappears, yellow oxide of mercury ointment (gr. vi. to ʒi.) should be used regularly. Constitutional treatment will depend upon the cause. If the Wassermann reaction is positive, grey powder should be given, followed by syrup. ferri iod. In other cases cod-liver oil and general tonics, and in all cases change of air if possible, and general hygienic measures. "606" is of little service in this disease.

Punctate Keratitis (keratitis punctata, "K.P.") is not a disease of itself, but arises in the course of a chronic irido-cyclitis. The exudate from the inflamed tract is deposited in little dots on the posterior surface of the cornea, gravitating to the lower part. It disappears as the deeper inflammation subsides.

Sclerotizing Opacity is a slowly progressive inflammation or degeneration of the cornea, associated with inflammation of the sclerotic in the neighbourhood, and followed by a dense white opacity in the part of the cornea affected. The treatment is that of scleritis.

Staphyloma of the cornea is a bulging cicatrix of a part or whole of the cornea. If it is extensive it may call for enucleation of the eyeball, but in children this should be postponed as long as possible; for the empty orbit will not develop as well as the full one, and asymmetry of the face will result.

Conical Cornea is a rare condition in which the cornea slowly assumes a conical shape, and may eventually become opaque and ulcerate at the tip of the cone. It begins in childhood, and affects women more often than men. Both eyes are nearly always affected. The cause is unknown. Slight cases may be helped by cylindrical glasses, more serious ones by cauterization or excision of the apex of the cone, so as to establish a contracting scar.

Malignant Growths of the cornea are rare, except as extensions from surrounding parts.

THE SCLERA.

Inflammation of the sclerotic is not very common. It may be superficial or deep.

Episcleritis is a local inflammation of the superficial layers of the sclera and the overlying conjunctiva, and shows as a small ill-defined area of infiltration, slightly elevated, red or yellow, tender on pressure, and surrounded by injection. It cannot be moved on the sclera. There is generally some pain, photophobia, and lacrymation. It generally disappears in a few weeks, only to reappear at another point, running on for long periods, and leaving the sclerotic discoloured. The commonest cause is tubercle or rheumatism, and the treatment is generally directed along these lines, with hot fomentations locally. If there is pain, heat and atropine will relieve it.

Scleritis is much like episcleritis, but the deeper layers are involved also, and the swelling is more diffuse. There may be swelling from infiltration at first, but later the whole sclera thins and bulges in places. The symptoms are much the same as in episcleritis. The disease often lasts for years, affecting first one part and then another. It is more common in women than in men. The cause is usually tuberculous, though it is due sometimes to rheumatism and syphilis. The treatment is the same as for episcleritis. Tuberculin should be given in suitable cases.

THE IRIS AND CILIARY BODY.

The iris, ciliary body, and choroid, together form the middle tunic of the globe, and are known as the *uveal tract*. Inflammation of the iris involves the ciliary body more or less, so iritis and cyclitis are best considered together. For clinical purposes we may divide and classify iritis as—(1) Acute ; (2) chronic ; (3) purulent. When there is much exudation, and consequently many adhesions of the iris to the capsule of the lens, it is called " plastic iritis " ; when there are few adhesions, " serous iritis."

The signs and symptoms of the various forms of iritis are best remembered and explained by remembering where the exudation from the iris and ciliary body may appear, and the results it may lead to. It is generally a sticky lymph, and shows itself in various ways :

1. The substance of the iris is more or less discoloured and thick-looking, owing to exudation into its tissues. This is specially marked, as regards swelling, in the first stage of purulent iritis.

2. Lymph may be deposited in small particles on the posterior surface of the cornea—*keratitis punctata*, or " *K.P.*" This is specially characteristic of chronic irido-cyclitis (see p. 453).

3. The exudation renders the aqueous turbid. This is seen best in ordinary acute iritis.

4. Lymph may glue down the pupil to the lens capsule. Each adhesion is known as a *posterior synechia*. If there are adhesions all round the edge of the pupil, it is known as *ring* or *annular synechia*, and the anterior chamber is shut off from the posterior—*exclusion of the pupil*. When this occurs, the proper drainage of fluids from the eye is interfered with, the tension rises in the posterior chamber, and the iris is bulged forwards—*iris bombé*. If the whole iris is glued flat

down to the lens we have *total synechia*, and if the pupil is filled with lymph we have *occlusion of the pupil* and consequent blindness.

5. Exudation may be poured into the vitreous, causing floating opacities in it. This is seen specially in cyclitis.

Acute Iritis.—Ordinary acute iritis begins suddenly, with marked symptoms of pain, irritability, injection of the conjunctiva, and more or less impairment of vision. It may come on in a few hours, and usually lasts several weeks, though in some cases no more than a few days. It may leave no trace, but generally posterior synechiæ form and persist. There is a great tendency to recurrence. Acute iritis is oftenest confused with catarrhal conjunctivitis and acute glaucoma. The following table, adapted from May and Worth's textbook, gives the differential diagnosis:

Acute Iritis.	Catarrhal Conjunctivitis.	Acute Glaucoma.
1. Iris dull and discoloured	1. No change in iris	1. Iris congested and dull
2. Pupil small, sluggish, irregular after use of atropine	2. Pupil normal	2. Pupil dilated, immobile, greenish in hue
3. Anterior chamber normal depth; often is muddy	3. Anterior chamber normal	3. Anterior chamber shallow
4. Cornea transparent	4. Cornea transparent	4. Cornea steamy and insensitive
5. Ciliary injection; conjunctival in acute stages	5. Conjunctival injection only	5. Ciliary and conjunctival injection
6. Lacrymation only	6. Sticky discharge also	6. Lacrymation only
7. Tension usually normal	7. Tension normal	7. Tension increased
8. Pain radiating to forehead, temple, and nose. Worse at night	8. Discomfort; no severe pain	8. Severe pain in and about eye
9. Dimness of vision	9. No dimness, or slight blurring only, from discharge	9. Marked dimness; may be blindness

Chronic Iritis may come on most insidiously, with little or no pain or irritation, the only sign being a faint pink ring round the corneal margin, caused by injection of the ciliary vessels. In other cases there is neuralgic pain in the forehead, which may persist for years without its origin being discovered, till extension of the inflammation backwards to the choroid leads to loss of sight. The ciliary body is always involved, and there is often tenderness on pressure over it. The pupil may be small or fairly large, but does not respond to stimuli. Both eyes are nearly always affected, but not simultaneously. Keratitis punctata and vitreous opacities are common. Alterations of tension in the eye often occur, the eyeball becoming hard at first, afterwards softening and shrinking, with complete loss of sight. Chronic iritis may end in loss of vision either by blocking of the pupil by lymph, by extension of the inflammation backwards to the choroid and retina, or by the above-mentioned raising of the tension (glaucoma), with subsequent softening.

Purulent Iritis is a rapidly spreading inflammation due to the entrance of infection, generally through a wound, but occasionally by the blood-stream in septicæmia. The iris becomes greatly swollen, and the anterior chamber filled with pus and blood. Rapid destruction of the eye follows.

Pathology.—Acute iritis is characterized primarily by hyperæmia, followed by exudation of cellular and perhaps fibrinous products, which may be absorbed or become organized. In chronic iritis the exudate

FIG. 62.—POSTERIOR SYNECHIÆ FOLLOWING IRITIS.

The margin of the iris is adherent to the anterior capsule of the lens. Some pigment from the posterior surface of the iris is also adherent.

(Mayou, "Diseases of the Eye.")

may be fluid, with solid elements, which are deposited on Descemet's membrane (keratitis punctata); or fibrinous, filling the chambers with lymph.

Causes.—In a few cases iritis is caused by direct injury to the eye, but generally it arises from constitutional causes, the infection reaching the eye by the blood-stream. Secondary syphilis, rheumatism, gonorrhœa, and various acute infective diseases are common causes

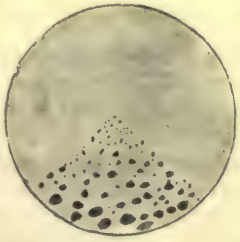


FIG. 63.—KERATITIS PUNCTATA ("K.P.").

Due to the cellular exudation in cyclitis being deposited on the back of the cornea. The triangular form is due to the movements of the eye.

(Mayou, "Diseases of the Eye.")

of acute iritis, while the chronic form is more often due to tubercle, tertiary or inherited syphilis, or the presence of a traumatic inflammation in the other eye (sympathetic ophthalmia). In infancy iritis is generally due to inherited syphilis; in older children to inherited syphilis or traumatism; in adults to acquired syphilis, rheumatism, or gonorrhœa; in older people it is most often seen associated with pyorrhœa alveolaris, ulcer of the cornea, or after operations on the globe.

Treatment.—The general lines of treatment are three : (1) To dilate the pupil, and keep it dilated till the inflammation subsides. (2) To relieve pain and secure rest for the eye. (3) To treat any constitutional ailment that may be the cause of the iritis.

For the first object the use of atropine is desirable. A drop of liq. atrop. sulph. is instilled into the conjunctival sac four times a day at first, and less often once the pupil is well dilated. If symptoms of atropine-poisoning should appear, another salt, such as sulphate of daturine or duboisine, may be substituted. The use of the mydriatic is to keep the iris away from the lens, to prevent the formation of synechiæ, and to break them down when they have formed, to place the ciliary muscle at rest, and to act as a direct sedative to the iris. Hot applications, as hot as can be borne, will relieve pain. Leeches or wet-cupping are effective in severe pain, and counter-irritation is specially useful in rheumatic iritis. If the pain is so severe as to need a hypnotic, the best is a hypodermic of morphia late in the afternoon or a full dose of Dover's powder at night. Free perspiration helps the action of other remedies. "606" and mercury should only be used in syphilitic or sympathetic cases.

Fig. 64.—Persistent Pupillary Membrane: the Remains of the Anterior Portion of the Fœtal Vascular Capsule of the Lens.

Note that this originates from the surface of the iris. Compare with Fig. 62.

(Mayou, "Diseases of the Eye.")

As regards general management, rest in a darkened room in severe cases, or protection of the eye with smoked glasses in milder ones, is called for. The general medical treatment will be according to the suspected cause. Surgical treatment is often called for in chronic iritis, where exclusion of the pupil may threaten to destroy the eye. An iridectomy may re-establish communication between the anterior and posterior chambers, and so preserve sight; but frequently in bad cases the opening in the iris fills up with lymph, and the ultimate result is disappointing.

Congenital Defects of the iris are not often seen. *Coloboma* is a gap in the iris, looking as if caused by an iridectomy, except that the edges of the gap are rounded off. It may be bilateral or associated with other congenital defects. *Persistent pupillary membrane* is seen like a cobweb across the pupil, hanging loose when the pupil is contracted, stretched tight when the pupil dilates. *Aniridia*, or absence of the iris, sometimes occurs.

Tumours of the Iris are not common, except as extensions from neighbouring parts. **Tubercle** of the iris sometimes occurs as a soft-looking greyish-yellow growth, filling the anterior chamber in a few

weeks or months, and leading to destruction of the eyeball, and rarely to general tubercular infection. **Gummata**, nævi, cysts, and sarcomata also occur in the iris.

GLAUCOMA.

Glaucoma is a disease characterized by increase in the intra-ocular tension. It may arise from various causes, and may be acute or chronic; but whatever the cause or course, there is always some obstruction to the natural drainage of the fluids of the eye, and consequent rise of pressure. If it arises without previous disease of the eye, it is *primary* glaucoma; but if it is consequent on previously existing diseases, it is *secondary*.

Acute Glaucoma comes on suddenly, generally after several threatened attacks, with conjunctival injection and irritation, intense pain in the eye and head, often vomiting, and blindness more or less com-

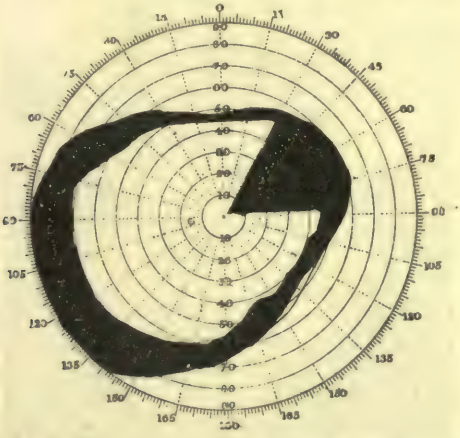


FIG. 65.—THE FIELD FROM A CASE OF CHRONIC GLAUCOMA.

Note the contraction on the nasal side.

(Mayou, "Diseases of the Eye.")

plete in a few hours. The cornea is steamy-looking, and as a result of this rings are seen round any light, such as a street lamp or a candle, which may be looked at before the vision is lost. There is often some anæsthesia of the surface of the cornea. The pupil is generally rather dilated and greenish in colour, and does not respond to direct stimuli, whilst the tension of the globe is raised, it may be to stony hardness. The acute stage may pass off in a few days, but if the tension is not relieved blindness will be permanent, and subsequent attacks will occur.

Chronic Glaucoma comes on very insidiously, with a gradual rise of tension and loss of vision, beginning at the periphery of the field, central vision being lost last. The pupil may be dilated or normal, and there may be no other external signs; but on ophthalmoscopic examination the disc is seen to be deeply cupped or excavated. Between acute and chronic there are all degrees of subacute attacks, injuring vision, but not destroying it at first.

Cause.—The cause is generally more easily traced in secondary than in primary glaucoma, for there is some obvious interference with the drainage of the eye in most secondary cases. The fluid of the eye is secreted by the ciliary body and iris into the posterior chamber, and, after passing through the pupil into the anterior chamber, escapes into the lymph spaces in the angle between the iris and cornea, known as the "filtration area." Annular posterior synechia, the result of repeated attacks of iritis, will shut off the anterior from the posterior chamber, and so cause glaucoma. Intra-ocular tumours, pushing forwards the iris against the cornea, and so blocking the filtration angle, may do the same thing. Perforating wounds or ulcers of the cornea, followed by entangling of the iris in the wound (anterior synechia), may drag the iris forward, with a similar result. In irido-cyclitis the thick albuminous secretion may block the filtration channels, and give rise to secondary glaucoma. The onset of primary glaucoma is often harder to account for, but certain things are known to predispose to it. It is a disease of advanced life, practically only

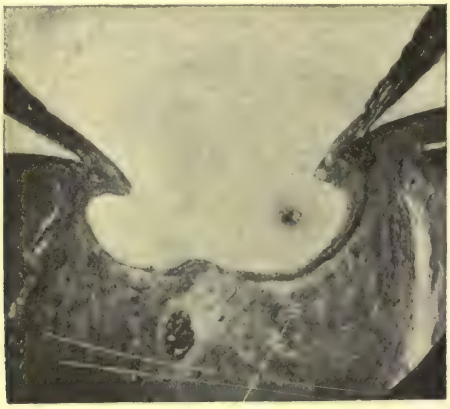


FIG. 66.—GLAUCOMA: CUPPING OF THE DISC.

(Mayou, "Diseases of the Eye.")

seen after fifty, and is more liable to occur in eyes with small corneæ, when the lens is large in proportion to the eye, and the iris naturally rather far forward. The use of a mydriatic may start an attack in an eye predisposed to it, owing to the iris lying in thick folds against the cornea and blocking the filtration angle; consequently atropine should be used with great caution in persons over fifty. The usual exciting cause of an acute attack is some disturbance in the circulation of the eye, brought on by exposure to cold or damp, hunger, loss of sleep, or similar depressing event. It is a *passive congestion*, not an active inflammation.

Diagnosis.—Acute glaucoma is often mistaken for conjunctivitis or iritis. The differential points are given in the table on p. 422, and need not be repeated. The diagnosis of chronic glaucoma will rest—(1) On the great loss of sight, especially at the outer parts of the field. The patient, looking straight towards you, may see your face plainly, but fail to see your hands held to one or other side. (2) On the rise of tension in the eye. (3) On cupping or excavation of the optic disc.

Secondary glaucoma is always a serious complication. It should be suspected if, during some deep-seated inflammation, the eye becomes more injected and painful, and sight gets rapidly worse. The rise of tension is the essential symptom.

Treatment.—Eserine is always indicated to begin with, and may rapidly relieve tension by flattening out the iris and drawing it away from the cornea. It acts best in slight acute cases, and may be of use in chronic ones. If it does not contract the pupil it will do no good. As regards general measures in acute cases, warmth, food, sleep, and aperients, will help. If eserine fails, the question of operation must be considered, trephining of the sclera being the operation most often done. If perception of light remains, it should be done, and the sooner the better. A small iridectomy, the iris being pulled out and buttonholed, should be performed. In old cases of glaucoma, with total loss of sight and frequent attacks of pain, the eye should be enucleated.

Buphthalmos or **Hydrophthalmos** is a condition usually first noticed in infancy or childhood, and is a congenital glaucoma. The eyes are very large, the tunics thin, due to the coats giving way under the intra-ocular pressure, and sight is poor. Sometimes the condition remains unchanged for years, but in other cases the cornea becomes opaque and the whole eye degenerates, or some trivial accident may cause rupture of the globe and loss of the eye. Trephining the sclera should be tried, but it is not very successful as a rule, except in the early stages.

THE LENS.

Changes in the lens may be either in its *transparency* or in its *position*. Loss of transparency is cataract. For clinical purposes cataract may be divided into—(1) Congenital; (2) senile; (3) secondary; (4) traumatic.

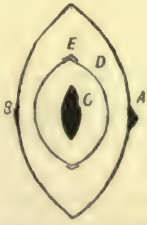


FIG. 67.—SHOWING THE POSITION OF LENTICULAR OPACITIES.

A, anterior polar cataract; *B*, posterior polar cataract; *C*, nuclear cataract; *D*, lamellar cataract, with rider, *E*.

(Mayou, "Diseases of the Eye.")

Congenital or **Lamellar Cataract** forms during the development of the lens, some layers or lamellæ being opaque, while others are normal. It is nearly always bilateral. The amount of interference with vision will depend upon the extent and position of the opacities. Commonly there is defective vision, which is only discovered when the child's education is begun. Lamellar cataract is frequently associated with rickets or congenital syphilis, and sometimes with other bodily or mental defects. The opacity is often not very dense, and is not

easily made out unless the pupil is dilated, when a ring of clear lens substance is seen surrounding the opaque part.

Treatment.—If the cataract is very small or not very dense, no treatment may be required, vision may rarely be improved by iridectomy, which provides a new pupil over the clear part of the lens. More often, however, the removal of the lens is called for. Under the age of thirty this is done by the operation of needling or discission. A needle is inserted through the corneo-scleral junction, the capsule of the lens incised, and the lens substance broken up by a rotatory movement of the needle. Through the torn anterior capsule the aqueous reaches the lens substance, which swells up and becomes opaque in a few days, and then gradually dissolves. The needling may have to be repeated several times, and the whole process may spread over months. Atropine is used to dilate the pupil and avoid risks of iritis from the irritation of the broken-up lens substance, which acts like a foreign body in the anterior chamber.

If at any time the lens swells too rapidly, secondary glaucoma may arise, which must be relieved by opening the anterior chamber and letting some of the lens substance escape (evacuation).

Senile Cataract is a progressive degeneration of the lens shown by loss of transparency, occurring almost entirely in persons past middle life. The chief or only symptom is interference with vision. This

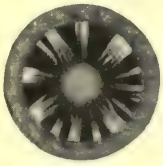


FIG. 68.—SENILE CATARACT.
Seen by focal illumination.

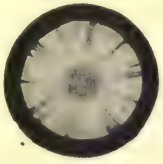


FIG. 69.—SENILE CATARACT.
Seen with the ophthalmoscope. The central opacity is nuclear; the marginal, peripheral striæ.

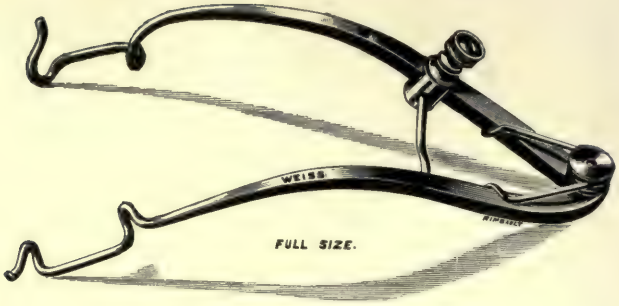
(Mayou, "Diseases of the Eye.")

may be simply dim, irregular, or diplopia may be complained of. The cataract is generally bilateral, though one side is often more advanced than the other. At first it may be confined to the nucleus of the lens or to its cortex, but it gradually spreads through the whole lens, until eventually it is an even grey all through, the cataract being then called *ripe*.

On inspection at an early stage nothing may be seen. On examination with the ophthalmoscope, the fundus will not be seen at all if the whole lens is opaque; but if the cataract is merely incipient, the opaque patches will stand out as black opacities against the illuminated fundus, appearing as a central cloudy area in nuclear cataract, and dark radiating spokes at the periphery in cortical cataract. When a strong beam of light is focussed on the lens from one side (oblique illumination), the opacities are seen grey against the dark fundus; and if the cataract is ripe the even grey opacity is seen to extend right up to the iris, which throws no shadow upon it.

Cause.—Very occasionally cataract is due to diabetes or to poisoning by ergot or naphthalene, but in the vast majority of cases no cause

PLATE LII.



Eye Speculum.

Graefe Knife.

Capsule Forceps.

Vectis.

Iris Forceps.

Iris Scissors.

CATARACT INSTRUMENTS.

[To face page 429.

can be traced; it seems to be simply a senile degeneration following the death of the epithelial cells lining the lens capsule. The immediate cause of the opacity is irregular swelling of the lens fibres, due to the osmosis of fluid through the lens capsule. This may progress quickly, leading to practical blindness in a few months, or it may progress for a time, and then remain almost stationary for years.

Treatment.—Operation is the only treatment. Before it is decided upon, the projection for light should be tested; otherwise one may remove the cataract only to find that the eye is useless owing to disease of the retina or choroid. The patient should be able to point at once to a lighted candle held 4 or 5 yards off, and if he fails to do this there is some defect present besides the cataract. Before operation attend to preliminary cleansing of the eye and the general health. See that there is no inflammation of the conjunctiva or lacrymal ducts, no cough, or pyorrhœa alveolaris, the presence of any of which may lead to disastrous results.

The steps of the ordinary extraction operation are as follows:

1. The eye is cocainized, then cleansed by irrigation with any non-irritating aseptic fluid, such as normal saline or boric lotion, and a speculum is put in.

2. The globe is held with forceps, and the cornea transfixed from edge to edge with a Graefe's knife, in a line 3 millimetres below the upper corneal margin. The cut is continued upwards by a gentle sawing movement till it is complete and a conjunctival flap formed.

3. An iridectomy is done, the edge of the iris near the pupil being seized in iris forceps, drawn out of the wound, and a piece cut off with iris scissors, so as to enlarge the pupil upwards towards the wound. While this is being done, the eye may be held with fixation forceps by an assistant.

4. The capsule of the lens is opened by scratching it with a cystotome, or a piece of it is torn away in toothed forceps.

5. The lens is expelled through the wound by gentle pressure with a blunt instrument over its lower edge.

6. The broken remains of the lens cortex are removed by gentle stroking of the cornea upwards towards the wound.

7. When the pupil is clear, the "toilette" of the wound is completed by freeing the iris from the wound if it is not already free, and also seeing that the wound is free from tags of conjunctiva or capsule.

The eyes are then bandaged, and the patient kept quiet in bed, talking and much moving being forbidden for several days. The first dressing is not generally done for three days, after which, if all is going well, the second eye may be kept uncovered.

FIG. 70.—FIXATION FORCEPS.

Variations in the Steps.—(*a*) If the patient is known to be very nervous, with little self-control, a general anæsthetic may be given.

(*b*) Some surgeons prefer to do the iridectomy some weeks or months beforehand, believing that it lessens the risk of iritis after the operation, and affords valuable information as to the character of the

patient and the state of his eye. Others omit the iridectomy entirely, removing the lens through the normal pupil, which is left intact—a more difficult operation, but one which gives more brilliant results if successful.

(*c*) The remains of the cortex may be removed by irrigation with a warm aseptic saline solution.

Accidents.—At any stage during the operation there may be an escape of vitreous, either due to abnormal fluidity of the vitreous or to faulty technique. If only a small amount escapes, it may not matter; but if much, vision is not likely to be good.

The lens, instead of rising into the wound, may show a tendency to sink, while the vitreous escapes. If this happens, it should at once be removed by inserting a vectis (a wire loop) below it.

A happily rare accident is intra-ocular hæmorrhage, which comes on with sudden severe pain and leads to complete destruction of the eye.

Iritis may set in after the operation, and is more likely to do so if much cortex has remained in the eye. It may lead to closure of the pupil with lymph.

A film of opaque capsule may remain in the pupil, known as "after-cataract," and require needling or cutting.

Finally, the wound may suppurate, generally as the result of infection from the lacrymal sac or conjunctiva. This may lead to closure of the pupil and blindness, or to complete destruction of the eye by panophthalmitis. Happily suppuration is now a rare event. If all goes well and the pupil is clear, a convex glass is given about three months after the operation to supply the loss of the natural lens.

Secondary Cataract is of several varieties.

(*a*) **Anterior Polar Cataract** is a small opaque spot on the anterior capsule of the lens, in the centre of the pupil, and affects vision seriously. It may be a congenital defect, or it may arise from a central perforating ulcer of the cornea. Treatment is generally of no avail unless an iridectomy helps.

(*b*) **Posterior Polar** or **Pyramidal Cataract** is often the result of some deep-seated disease of the eye. It is serious, and often progresses. Its treatment will be that of the affection causing it.

(*c*) **After-Cataract,** mentioned above, is best seen with the ophthalmoscope. It may be dense, closing the pupil and destroying vision, or it may be slight and filmy. If slight it may be removed by needling. If tough it is cut through with scissors, but often in this case it is due to the products of inflammation, and after it is cut away a fresh attack of iritis comes on, and the new pupil fills up again.

Traumatic Cataract arises from any injury, direct or indirect, which ruptures the lens capsule. The larger the rupture, the quicker the formation of the cataract. Very occasionally the broken-up lens matter is completely absorbed, dissolving in the aqueous, but generally its absorption has to be hastened by needling it—that is, stirring it up with a needle several times. If the patient is over thirty there will be a hard nucleus in the lens, which will not be absorbed, but must be removed through a corneal incision, as in senile cataract.

If signs of inflammation appear in the wounded eye, avoid operation and order atropine and rest, and the inflammation may subside. If it goes on to panophthalmitis, evisceration of the ocular contents should be performed.

Dislocation of the Lens may be (1) *congenital*, in which case it is often associated with other defects. (2) It may be *traumatic*, and is then often followed by cataract. (3) It may be due to *deep-seated disease* of the eye. Dislocation is indicated by iridodonesis (tremulous iris), the iris having lost its support flaps like a sail in a changing wind. If the dislocation is partial, the edge of the lens may be seen in the dilated pupil. If complete, a strong convex lens is needed for distant vision, such as would be required after a cataract operation, and much stronger than would be required for any ordinary error of refraction. Occasionally in traumatic dislocation the lens may be found in the anterior chamber or under the conjunctiva, in which case it may be possible to remove it, but this is not often the case.

THE VITREOUS.

The normal vitreous is an inert jelly. It contains 99 per cent. of water, and is held together, like substance enclosed in the hyaloid membrane, with a delicate network of fine fibrils of connective tissue.

Fluidity of the vitreous occurs when the fibrils degenerate or contract as the result of inflammation. It is common in cyclitis, glaucoma, and high myopia. Occasionally the fluid vitreous is found full of cholesterin crystals, which glitter in a very curious way when seen with the ophthalmoscope.

Opacities in the vitreous are generally due to inflammation in the surrounding parts, and are commonest and most abundant in irido-cyclitis.

Blood in the vitreous may arise from spontaneous rupture of a ciliary or retinal vessel in arterio-sclerosis or retinitis, or it may be due to a wound or blow. If small in quantity, it may be wholly or partly absorbed, or if much it may disorganize the eye and lead to complete blindness (retinitis proliferans).

THE RETINA.

Congenital defects are seen fairly often in the retina, in two forms : (1) **Persistent Hyaloid Artery,** running like a cord from the disc towards the back of the lens. (2) Opaque nerve fibre which appears as white striations, generally in the neighbourhood of the optic disc.

Embolism of the whole central artery or of one of its branches occurs occasionally with endocarditis. Occlusion from arterio-sclerosis is more common. There is blindness in the area supplied by the affected vessel, usually permanent.

Retinal Hæmorrhage is due to vascular disease following either local or constitutional causes, among the latter being renal disease and pernicious anæmia. It may be single or multiple, and may vary from a mere point to a destructive hæmorrhage covering a large part of the fundus. As a rule it is slowly absorbed, and after several months disappears, leaving usually a scotoma in the field of vision. Sometimes it becomes organized into fibrous tissue, and sometimes, if very profuse, leads to a condition known as "retinitis proliferans."

Retinitis occurs in many conditions, commonly due to systemic disease—*e.g.*, syphilis. In all forms there is more or less cloudiness of the retina ; there may be hæmorrhages and exudation, and disturbance of vision according to the extent and position of the part affected.

The patient generally complains of sparks or coloured lights seen before the eyes, or dark spots seeming to come between his eye and the object looked at. The course is generally slow, lasting for months, and the consequence is generally atrophy of the retina and underlying choroid in irregular patches, and consequent loss of vision in those parts of the field.

Retinitis Albuminurica is one of the commonest forms of vascular disease of the retina and is most important, for the presence of Bright's disease is often first shown by it. It is a neuro-retinitis, the disc as well as the retina being affected by œdema. The changes seen are generally characteristic. The disc becomes red and then swollen (papillo-œdema), and the surrounding parts of the retina somewhat cloudy. The vessels, especially the veins, are full and tortuous, and white spots appear in the retina, generally arranged in a stellate

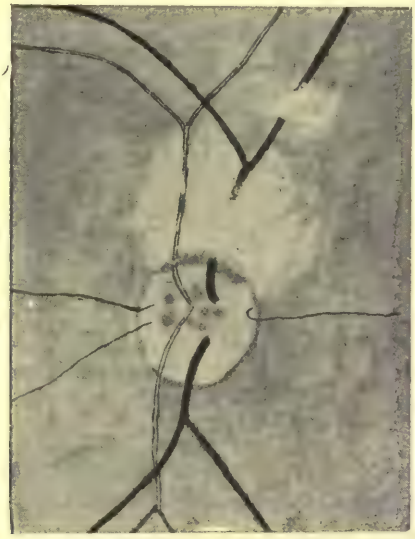


FIG. 71.—OPAQUE (MEDULLATED) NERVE FIBRES.

(Mayou, "Diseases of the Eye.")

form round the macula. There may also be retinal hæmorrhages. One eye is often affected before the other, but the second soon follows. The extent to which vision is lost depends, firstly, upon whether the macular region is affected or not, and, secondly, upon the presence or absence of uræmic poisoning, which may cause great loss of vision without corresponding change in the retina.

Cause.—It is essentially a toxic affection, and may occur in any form of nephritis with albuminuria, but it is most frequent in *small granular kidney*, less frequent in *large white kidney*, and rarest in *acute nephritis*.

Prognosis is always bad, except in cases occurring in pregnancy. The great majority of cases are fatal within two years, though a few may, with care and protection from cold, live longer.

Syphilitic Retinitis is common, but presents no typical appearances. There is a general fog over the retina, through which the disc and large vessels may be dimly seen, and there are spots of exudation,

sometimes very small. It occurs both in inherited and acquired syphilis. The diagnosis rests on the amount of diffused exudation and upon the history. The prognosis is much better than in other forms.

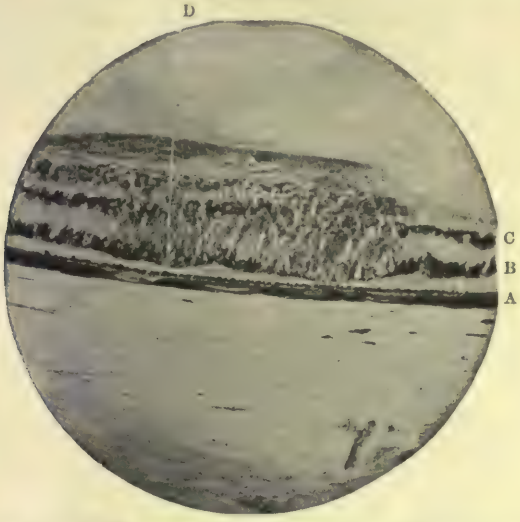


FIG. 72.—INTRA-RETINAL HÆMORRHAGE: ALBUMINURIC RETINITIS, SHOWING THE DESTRUCTION OF THE RETINA CAUSED THEREBY.

A, Sclerotic; *B*, choroid; *C*, retina; *D*, hæmorrhage.

(Mayou, "Diseases of the Eye.")

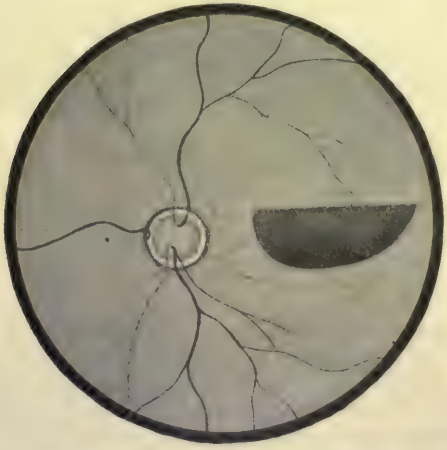


FIG. 73.—SUBHYALOID HÆMORRHAGE.

Note the boat-shaped appearance due to the separation of the hyaloid membrane of the vitreous from the retina, the blood sinking to the lower part.

(Mayou, "Diseases of the Eye.")

Thrombosis of the Central Retinal Vein is most often seen in connection with retinal vascular sclerosis. There is haziness of the retina,

and numerous small hæmorrhages all over it, sometimes with optic neuritis. It comes on suddenly, leading to loss of vision, which may or may not recover. It is sometimes followed by occlusion of the central retinal artery. Glaucoma may supervene after some months' interval, and can often be diagnosed by the formation of new vessels on the iris. Generally only one eye is affected. It is oftenest seen in patients between forty and sixty years of age, with arterio-sclerosis.

Treatment of retinitis is mainly that of the constitutional cause, if such can be found. Locally not much can be done, but in acute cases the eyes should be protected by smoked glasses, reading forbidden, and wet or dry cupping to the temples ordered.

Retinitis Pigmentosa is a slow vascular degeneration of the retina and choroid, with deposit of pigment in stellate masses like bone corpuscles. It is often hereditary, and often associated with mental

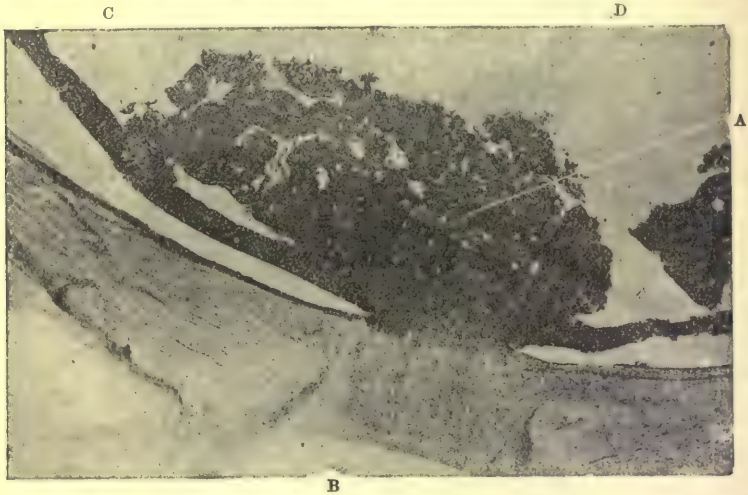


FIG. 74.—GLIOMA OF THE RETINA (*A*) COMMENCING TO INVOLVE THE OPTIC NERVE (*B*).

The glioma growing from the nuclear layers of the retina, *C*, has converted it into a mass of new growth. The portion of the growth *A* is fungating into the vitreous, *D*.

(Mayou, "Diseases of the Eye.")

defects or deaf-mutism. Both eyes are affected, and there is slowly progressing loss of sight due to the contraction of the field of vision (ring scotoma), often leading to complete blindness about the fiftieth year. The defect of the sight is most marked in a dim light (night-blindness). The cause is unknown, but consanguinity plays a part. Secondary cataract often occurs. Treatment is of no avail.

Detachment of the Retina is not rare, the membrane being loosely attached to the choroid, and easily separated from it. Detachment occurs in four conditions:

1. Much the commonest is in *high myopia*, where the coats of the globe stretch and the retina becomes loose.
2. *Traumatic*, following blows on the eye.

3. *Idiopathic*, usually in young adults, and often bilateral, from no known cause.

4. Due to *tumours* of the choroid. This form is sometimes recognized by the colour, or the vessels of the new growth being seen through the detachment or by the raised tension of the globe.

Diagnosis.—There is a loss of the field of vision, depending on the extent of the detachment. The tension of the eye may be lowered, unless there is a tumour. When the pupil is dilated, oblique illumination or ophthalmoscopic examination will show the soft grey folds of the retina, with the vessels like black lines running over them, appearing and disappearing on the folds.

The course is generally from bad to worse, though sometimes it remains stationary for years.

Treatment is very unsatisfactory, and about as many cases recover without any treatment as with it. Various methods of treatment are—(1) Prolonged rest in bed, with the head fixed by sandbags. (2) Removal of the fluid by puncture behind the detachment, and an attempt to fasten the retina down by causing slight inflammation, by galvanocautery. (3) Coagulation of the fluid by electrolysis. (4) Medication to promote absorption of the fluid, such drugs as iodide of potash, inunctions of mercury, or injections of pilocarpine, being used. In the case of a tumour the globe should be removed.

Glioma of the Retina.—This is a highly malignant tumour, probably always congenital, and usually noticed some time in the first three years of life. In 20 per cent. of the cases both eyes are affected. As the patients are too young to complain of the vision, it is not generally noticed till it shows in the eye as a pale yellow or white reflex from behind the lens. High tension may distinguish it from *pseudo-glioma*, where there is pus in the vitreous and the eye is soft. Glioma is sometimes seen in several members of a family.

Pathology.—It is a soft vascular tumour of round cells, arising from the retina, and characterized by patches of necrotic tissue.

Prognosis is very bad, less than 10 per cent. of cases being cured by removal of the eye. The others die from extension of the growth up the nerve to the brain, or by local recurrence and exhaustion.

Treatment.—When confined to the eye, the globe should be removed, cutting the nerve as far back as possible; if the growth has extended to the orbit, the latter should eviscerated.

THE CHOROID.

The choroid is a highly vascular and pigmented membrane, often affected by diseased processes. Changes in it can only be seen with the ophthalmoscope.

Choroiditis is common at all ages. All serious changes in the choroid affect the overlying retina also. Choroiditis may be *plastic* or *purulent*, the former being more common. According to the part it affects it is called *disseminated* or *central*, one being scattered over the fundus, and the other confined to the macular region. The inflammation occurs in patches, often about the size of the disc. At first they are ill-defined, and of a warm cream colour. Later the exudation is absorbed, and there may be a patch of atrophy left in its place,

showing gleaming white sclerotic, with a few vessels crossing it, and patches of dense black pigment round its side. The chief symptom is loss of vision, depending upon the extent and position of the patches of inflammation. There are often also complaints of flashes of light, sparks, or other unpleasant sensations in the eye. Both eyes are commonly affected.

Pathology.—In the chronic form there is congestion and infiltration, with leucocytes and œdema. Later there is proliferation of pigment cells.

Cause.—Syphilis, both acquired and inherited, is the commonest cause of extensive inflammation in the choroid. Tubercle causes a few cases. Staphylococcal (septic) lesions are a frequent cause of solitary patches in the choroid.

Prognosis is bad as regards recovery of good vision, but better in syphilitic than in other cases. Choroiditis may cause great disturbance of vision, but seldom leads to complete blindness.

Treatment.—Protect the eyes by dark glasses, and forbid reading, etc., during the active stage. Mercury and iodide should be tried in all cases, with leeches or wet or dry cupping. Cod-liver oil and iron should be given in children. Vaccines should be given in the tubercular and septic cases.

Exudative Choroiditis, or **Pseudo-Glioma,** is generally the result of some acute infectious disease in children. It is a sort of chronic purulent choroiditis, recognized by the yellow reflex from the pupil and the slow softening and disorganization of the eye.

Purulent Choroiditis is often the result of a septic wound, but may occur by extension of inflammation from neighbouring parts, or by endogenous infection, as seen in cerebro-spinal fever and typhus. The prognosis is bad. In acute cases there is generally panophthalmitis.

Sarcoma of the Choroid, usually of the melanotic variety, is much the most frequent neoplasm of the eye. It is always primary, and may occur at any age, though seldom before twenty, and oftenest between forty and fifty. It begins as a small knob at any part of the choroid, detaching the retina. It may not be noticed till fairly advanced, when the tension begins to rise. Progress may be exceedingly slow. Eventually it breaks through the sclera and invades the orbit. Enucleation is the only treatment. There are two dangers : (1) *local recurrence*, if enucleation has not been early and complete ; (2) *metastasis*, which is common, occurring within two years of removal. About 50 per cent. of the cases are permanently cured.

Other Neoplasms are rare, except by extension or secondary growth.

Coloboma of the Choroid is not very rare, and is easily mistaken for disease. It is a congenital absence of the choroid over its lower segment, leaving the white sclerotic visible below, due to imperfect closure of the fœtal ocular cleft.

Rupture of the Choroid occurs sometimes as the result of a blow. It is generally hidden by the hæmorrhage for a long time, but after some weeks may be seen as a curved line, generally near the macula.

THE OPTIC NERVE.

The optic nerve may be affected through various channels, which it is well to keep in memory while considering its diseases.

1. From its development and structure it forms part of the central nervous system, and may share in its diseases.

2. It is enveloped in sheaths which are continuous with the meninges.

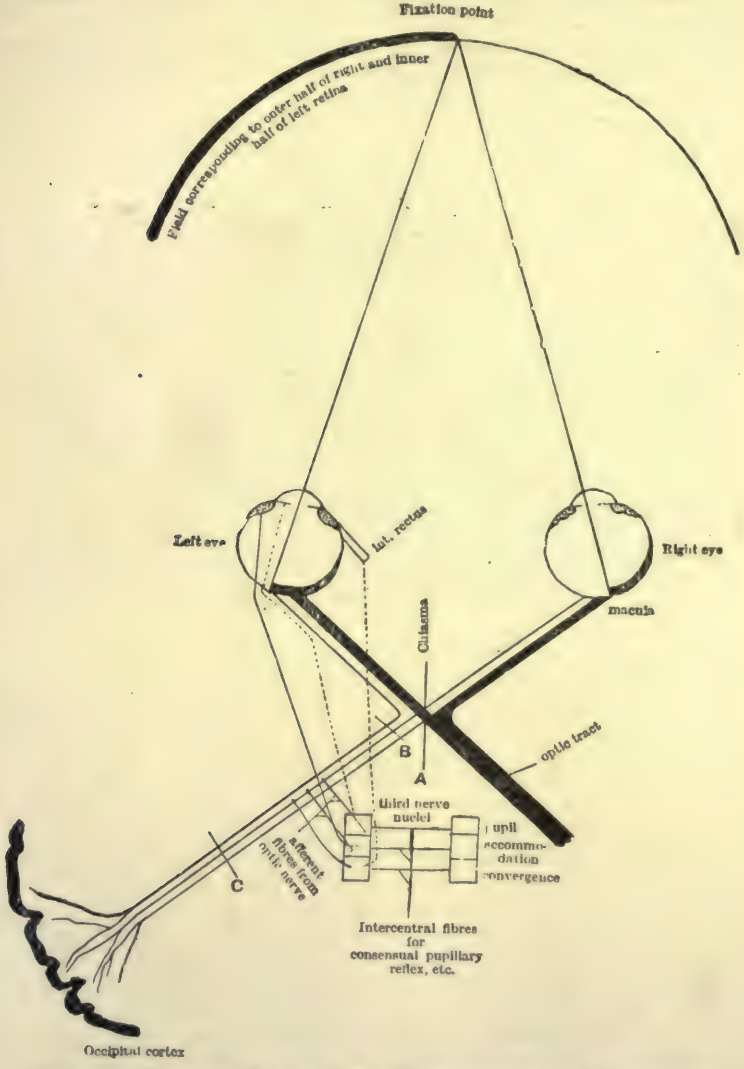


FIG. 75.—DIAGRAM OF THE OPTIC NERVES AND THEIR CONNECTIONS.

A lesion at *A* causes bi-temporal hemianopia; a lesion at *B*, homonymous hemianopia with hemianopic pupil reaction; a lesion at *C*, homonymous hemianopia, with reaction of the pupil to light.

(Mayou, "Diseases of the Eye.")

3. Its position in the base of the brain exposes it to injury from new growths, aneurism, etc.

4. In the optic canal it is exposed to the risk of injury, bone disease, etc., and in the orbit to orbital cellulitis.

5. Injury to the ganglion cells in the retina may be followed by degeneration of the optic nerve.

6. Inflammation of other parts of the eye may extend back to the optic nerve.

7. It may suffer from the influence of general disease, such as renal disease, syphilis, tubercle, etc.

Inflammation of the optic nerve is divided clinically into two forms :

1. *Optic Neuritis*, or *Papillitis*, where the signs of inflammation are seen in the disc.

2. *Retrobulbar Neuritis*, where the presence of inflammation in the nerve behind the eye is inferred from the symptoms.

FIG. 76.—OPTIC NEURITIS.

A, Swollen œdematous nerve head; *B*, distended nerve sheath; *C*, retinal hæmorrhage; *D*, subretinal œdema; *E*, mass of tubercle involving the nerve pressing on the retinal vessels, *F*.

(Mayou, "Diseases of the Eye.")

Optic Neuritis, or **Papillitis,** is only recognized by the ophthalmoscope. The name of *choked disc* is given to intense œdema, such as accompanies brain tumours, but it only differs from ordinary papillitis in intensity.

Symptoms may be absent or slight where the condition is due to œdema. There may be a sensation of flashes of light, and later on interference with vision, but it is necessary to remember that marked papillitis may exist for some time without corresponding loss of vision; but where there is true inflammation in the nerve, immediate and sometimes complete loss of vision takes place, with comparatively slight changes at the optic disc.

Ophthalmoscopic examination in an early stage or in slight cases shows the edges of the disc obscured, and the veins large and tortuous. Later, in the more severe cases, an elevated mass of tissue, yellow and foggy-looking, with the greatly enlarged vessels appearing out of it,

occupies the place of the disc. Small hæmorrhages are sometimes seen around it. This is the condition known as "choked disc."

Course.—Optic neuritis may last for months without affecting vision much, or there may be slow or sudden loss of vision, partial or complete, depending upon the amount of interference with the nerve fibres. As the swelling subsides, atrophy generally follows (*consecutive atrophy*); and the longer the duration and greater the intensity of the neuritis, the more complete is the atrophy likely to be.

Pathology.—Œdema of the nerve head is due to the pressure on the central retinal vein at its exit from the eye in the case of intracranial tumours by fluid in the nerve sheaths which communicate with the intracranial fluid. The cause of true inflammation of the nerve cannot often be traced.

Etiology.—Brain tumours account for 67 per cent. of cases, syphilis for 13 per cent., tuberculous disease for 4½ per cent., other cases being due to abscess, nephritis, hydrocephalus, etc. It is generally bilateral, unless there is a unilateral cause, such as pressure from a growth in the orbit. The connection with brain tumour is very important, as papillitis is present in about 95 per cent. of cases, more often first on the side of the lesion, but by no means always so.

Prognosis.—In the case of brain tumours, vision may remain good or recover if the intracranial pressure be relieved by trephining. If there has been great and long-continued swelling, there is more likely to be consecutive atrophy.

Treatment must be that of the cause where possible. Locally one may order protection with dark glasses, rest, and wet or dry cupping.

Retrobulbar Neuritis begins with marked disturbance of vision, and there is often almost complete blindness before any sign can be seen in the disc. The nerve fibres which supply the region of the macula are the most easily injured by pressure or inflammation; consequently central vision is first affected, and there is a blind area or scotoma in the centre of the field. If the blindness in this area is complete, it is called an *absolute scotoma;* but if it is for certain colours only, it is a *relative scotoma*. Retrobulbar neuritis occurs in two quite different forms—acute and chronic.

Acute Retrobulbar Neuritis has a very sudden onset with pain in the eyes and head, often general symptoms, fever, etc., and disturbance of vision, which may go as far as complete blindness in one or two days, or even hours. It generally affects one eye, and if vision is much reduced, the pupil may be inactive to light. There is a feeling of stiffness or pain on moving the eye, and pain on pressing the closed lids with the finger. The fundus is normal at first, but papillitis frequently appears in a few days, not generally very intense.

Pathology.—This is a primary interstitial neuritis. There is inflammation of the connective tissue of the septa, and consequent pressure on the nerve fibres. If the pressure is severe and long-continued, the fibres are destroyed and undergo fatty degeneration.

Etiology.—It is generally seen in patients under thirty, and more often in females. It may accompany encephalitis or myelitis, or follow influenza, or appear without any other lesion or known cause.

Prognosis must be guarded. The more intense the papillitis, the more likely is atrophy to follow. In some cases vision returns to normal.

Treatment may be on one of two lines—either brisk salivation with mercury, or sweating with hypodermic injections of pilocarpine. If only one eye is affected, rest and protection must be given to the other.

Chronic Retrobulbar Neuritis is better known as **Toxic Amblyopia.** It is generally due to excessive use of tobacco or alcohol, or both, but may also be produced by some drugs, such as stramonium and carbon bisulphide. The general type of case met with is that of a man of forty or more, a heavy smoker or chewer for years, perhaps drinking spirits freely, who finds his vision becoming dim but sees better in a dull light, and also finds a difficulty in telling colours. When tested with ordinary type or large coloured objects, vision may be normal; but when tested (each eye separately) with small coloured objects—say the size of a shilling, held 2 feet from the eye—colour vision is found defective, specially for red and green. This is because in the early stage there is a relative

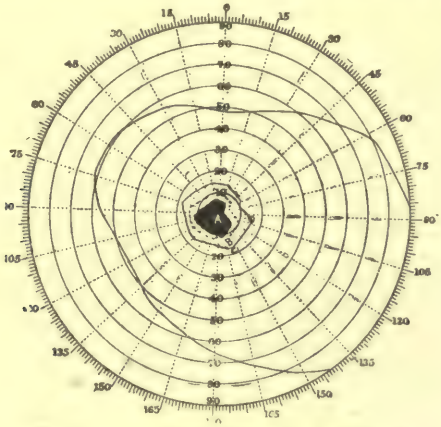


FIG. 77.—CENTRAL SCOTOMA IN A CASE OF RETROBULBAR NEURITIS.

A for white; *B* for red; *C* for green.

(Mayou, "Diseases of the Eye.")

scotoma only; and when the retinal image is larger than the area of the scotoma, the colours are recognized. Diagnosis rests on the presence of a relative scotoma in both eyes, the maintenance of fair general vision, the absence of pain on pressure, the age and habits of the patient, and on the progress of the case.

Prognosis is good if the patient comes under treatment while the scotoma is still a relative one only, and if he submits to treatment, abstaining *entirely* from the toxic agent, in which case vision will probably soon return to normal. But if he persists in his habits, the scotoma will become absolute, and optic atrophy will follow.

Pathology.—There is a chronic interstitial neuritis, affecting the bundle of fibres supplying the macular region specially. There is no tendency to papillitis.

Etiology.—The free and long-continued use of both tobacco and alcohol is much the commonest cause of toxic amblyopia. Less common is the use of tobacco alone, and still less common is alcohol alone. The tobacco is generally "shag," and the alcohol in the form of spirits.

Treatment.—Abstention from the toxic agents is absolutely essential. Small doses of strychnine, Turkish baths, or sweating, and abundant exercise in the fresh air, are beneficial. Washing out the system by free drinking of water, weak tea, lemonade, and such innocent drinks, has been recommended, and seems to hasten the elimination of the toxic agent.

Optic Atrophy.—Atrophy of the optic nerve is due to disappearance of the nerve fibres. The papilla loses more or less of its warm tint, and becomes white through disappearance of the capillaries or the appearance of new connective tissue. There is loss of vision, generally progressive.

Atrophy following papillitis is known as *consecutive atrophy*, other forms of atrophy being *simple atrophy*, either primary or secondary.

Consecutive Atrophy follows papillitis ; it may be in a few weeks, or it may be in some years. The disc generally becomes bright white, owing to the presence of new connective tissue, and the vessels are

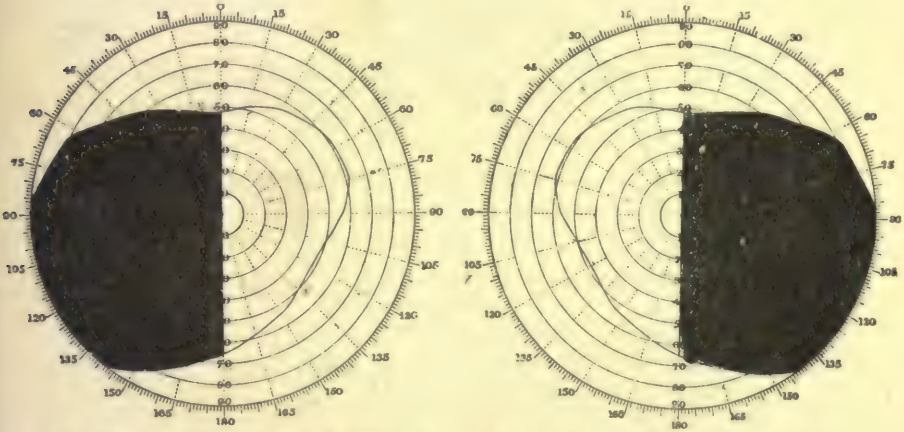


FIG. 78.—BI-TEMPORAL HEMIANOPIA, FROM A CASE OF ACROMEGALY DUE TO PRESSURE ON THE CENTRAL PORTION OF THE CHIASMA.

(Mayou, "Diseases of the Eye.")

more or less contracted. There are often signs of old papillitis, such as slight woolliness of the edges of the disc, or patches of pigment or of choroidal atrophy near its margin. Section of the nerve shows it to be thinned, the septa thickened, and the nerve fibres degenerated.

Simple Atrophy may be primary or secondary. It does not follow inflammation in the nerve, and the change in appearance of the disc, may be less marked than in the consecutive form, as there is not the same increase in the connective tissue. There is a gradual wasting of the nerve fibres, and the disc becomes a greyish white with a mottled appearance, due to the lamina cribrosa being visible.

Primary Atrophy is often hereditary, and generally bilateral. It may occur in any form of cerebro-spinal disease, but specially in tabes. About 50 per cent. of tabetic patients have atrophy of the optic nerve, and it is often a very early sign, appearing years before other symptoms. It affects both eyes, and, though there may be slight temporary improvement, it goes on to complete blindness if the patient lives long enough. It is also seen occasionally in disseminated

sclerosis, general paralysis, chorea, epilepsy, diabetes, and after some fevers. Hereditary cases often occur, affecting sometimes the males only, each member of a family in turn becoming blind at a certain age, perhaps eighteen or twenty-five. It is sometimes preceded by papillitis.

Secondary Atrophy follows lesions of the retina, nerve or optic tract, caused by inflammation, neoplasms, hæmorrhages, injuries, etc.

Symptoms of Optic Atrophy.—There is gradual loss of central vision, with contraction of the field at the periphery, specially for colour in many cases, and change in the appearance of the disc as described above.

Diagnosis.—Optic atrophy cannot be diagnosed from paleness of the disc alone, as this may be physiological ; there must also be loss of central vision and contraction of the field.

Prognosis.—In consecutive atrophy the loss of vision does not generally progress for long, and what vision is retained after a little time will probably be permanently kept. In simple atrophy the prognosis will depend upon the cause. In tabes it is bad, though the loss may be slow. In disseminated sclerosis it is seldom completely lost, and may even improve considerably. In most other cases primary atrophy progresses to complete blindness.

Treatment is very hopeless. Large doses of mercury and iodide of potash may be tried, or strychnine, but if no benefit is seen in a few weeks medication will be useless.

Amblyopia and Amaurosis without Ophthalmoscopic Changes.—*Amblyopia* is the term generally applied to defective vision, and *amaurosis* to blindness, total or almost so, without obvious changes in the eye in either case.

Congenital Amblyopia is often seen with squint or as a result of intra-uterine inflammation.

Night Blindness is a condition in which the retina becomes less sensitive to light, and so vision is bad in a dull light. It is oftenest seen in connection with the exposure of the eyes to bright light, in a poorly nourished person. It is also seen in retinitis pigmentosa, and as a congenital condition.

Colour Blindness is not very rare. It is seen much more often in men than in women. It occurs as a congenital defect, and is also seen in toxic amblyopia and in atrophy of the optic nerve. None of the theories to account for it are satisfactory. The generally accepted test is Holmgren's, which is made with skeins of wool. A bundle of all colours mixed is placed before the patient, and he is given three test skeins to which he has to find matches in the bundle. The tests are—(1) A light pure green ; (2) a rose pink ; (3) red. With the first the normal person matches greens, the colour-blind adding fawn, grey, etc. With the second test the colour-blind may add green or purple ; and with the third he puts green or brown, or other dark colours. Even with careful testing some colour-blind persons can pass this test, and efforts are now being made to introduce a more satisfactory one. A colour-blind person who confuses red and green is specially dangerous in railway or steamship work, because of the risk of confusing signals. An Edridge-Green lantern should be used for this purpose.

ERRORS OF REFRACTION.

The varying curvature of the cornea and lens, and the varying density of all the media through which light passes on its way to the retina, alter the refractive powers of the eye, and such errors of refraction may be corrected by proper glasses. It is well to remember that, while the foundation of such correction is a knowledge of optics, a knowledge of the anatomy and physiology of the eye is also necessary, and that the correction should be made by a medical man, and not by a tradesman whose business it is to make and sell the glasses.

All measurements in refraction work are now made in the dioptric system. In this system lenses are numbered according to their refractive power, the unit, or diopter, being a lens of 1 metre focal length, marked +1 D if convex, or −1 D if concave. A lens of ½ metre focal length is a 2 D lens, ⅓ metre is 3 D, and so on. The test types in general use are numbered according to a convenient but arbitrary standard, in which normal vision is considered to be such as will distinguish letters which subtend an angle of 5′ at the eye, while each limb subtends an angle of 1′. The types used are generally such as would subtend these angles at 60, 36, 24, 18, 12, 9, and 6 metres, and the patient is placed at 6 metres from them. Each eye is tried separately. Suppose with the right eye the patient reads the second, or 36-metre, line, sitting at 6 metres distance from it, one marks R, $V = \frac{6}{36}$. If with the left he reads the 6-metre line, one notes L, $V = \frac{6}{6}$, which is normal vision. Lower degrees of vision than $\frac{6}{60}$ may be marked as counting fingers at so many feet; or if only the hand can be seen, and no fingers counted, then V = bulk only; or if it is not seen, but light is perceived, one notes V = P L (perception of light), or if not even that is seen, then V nil.

Near vision may be poor even though distant be good, for accommodation is needed for near vision, and the power of accommodation decreases with age. At 20 the accommodation is 10 D; that is, the eye can accommodate for a point $\frac{1}{10}$ metre off, described as the "near point." At 30 the power of accommodation is 7 D, at 40 it is 4·5 D, and at 50 it is 2·5 D; at 60 it is 1 D, and at 70 nil. When the power gets less than about 3·5 D the eye is no longer able to focus for ordinary reading distance, and the print has to be held far off—a condition known as **presbyopia.** To correct this the power of accommodation must be ascertained, and a lens ordered which will bring it up to 3·5. For instance, if the patient's near point is 50 centimetres, or ½ metre, off, his power of accommodation is 2 D, and he needs +1·5 lenses to bring his power up to 3·5 D.

General Examination for Errors of Refraction.

1. Test the distant vision of each eye separately by means of Snellen's test types at 6 metres.

2. Find the nearest point at which small print can be clearly read. If one is dealing with an adult, and finds distant vision normal and the "near point" too far off, this examination will suffice to show that the condition is presbyopia (*vide supra*).

3. If distant vision is not normal, try whether it is improved by glasses; but this examination should be supplemented by another method—namely, retinoscopy, or the shadow test.

4. For retinoscopy the examiner seats himself as for an ophthalmoscopic examination, but a metre from the patient, and with a concave mirror throws the light into the patient's eyes, moving it from side to side and up and down. If the light moves in the eye as it does on the face, it is said that "the shadow goes with you," but if it moves in the opposite direction it "goes against you." The former indicates myopia, and the latter the normal eye or hypermetropia. The reverse is the case if a plane mirror be used. If the former is found, concave glasses are put in front of the eye, higher and higher till one is found which just turns the shadow and makes it go against you, and this is the measure of the myopia. Similarly, when the shadow goes against you, the convex lens which turns it is the measure of the hypermetropia. In each case a small correction has to be made, owing to the fact that the shadow goes against one in the normal eye, so about $\frac{1}{2}$ or $\frac{3}{4}$ D has to be added to the concave lens, and the same subtracted from the convex lens.

Often we find that the lens which turns the shadow in one meridian does not turn it in another at right angles to it, showing that the refraction differs in the two meridians, and the corneal surface is not spherical: this is *astigmatism*.

In patients under fifteen or so the pupils should be dilated by the use of atropine drops (gr. ii. to ʒi.) for a few days before examination. From fifteen to twenty or twenty-five, homatropine and cocaine drops (2 per cent. each) may be used for an hour. The necessity for a mydriatic rises from the fact that there is often a tonic spasm of the ciliary muscle, specially after much near work, which may entirely vitiate the results of examination, and the younger the patient the more likely is this to occur. After twenty-five or so it is not found, and though a mydriatic greatly facilitates examination, it is not necessary. A second examination is made when the effects of the mydriatic have disappeared, which is in twenty-four to forty-eight hours with homatropine, and two to three weeks with atropine. At this second examination glasses are tried, chosen on the basis of the former examination.

Hypermetropia is an error of refraction caused by a congenital shortening of the eyeball in its antero-posterior axis, so that parallel

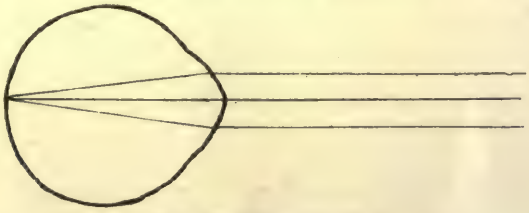


FIG. 79.—EMMETROPIA.

The rays are brought to a focus on the retina.

(Mayou, "Diseases of the Eye.")

rays come to a focus behind the retina instead of on it. To focus them on the retina, the rays must be made to converge by an effort of accommodation, and the symptoms depend upon the tiring of the ciliary muscle by this constant use. The greater the amount of hypermetropia, the less the power of accommodation to meet it; and

the more the eyes are used for near work, the more marked will be the symptoms.

Symptoms.—Distant vision is generally good, but the eyes tire at near work. Often when reading the letters get suddenly dim and mixed up ; this is due to the sudden relaxation of the overtired ciliary muscle. There is often headache caused by the strain. The "near point" is too far off, and the alteration in distance corresponds with the amount of the hypermetropia. A person of thirty should have 7 D of accommodation—that is, he should be able to accommodate for a point $\frac{1}{7}$ metre, or about 14 centimetres, from his eyes. But if he has

FIG. 80.—HYPERMETROPIA.

The rays, if prolonged, would come to a focus behind the retina.

(Mayou, "Diseases of the Eye.")

4 D of hypermetropia, he will need 4 D of his accommodation to overcome that, and to bring even distant objects to a focus on the retina; and then he will only have 3 D left to accommodate for near objects, so that his "near point" will be $\frac{1}{3}$ metre, or 33 centimetres off, and he will need glasses for near vision. When he is about forty-eight he will only have 3 D accommodation, and all will be insufficient to overcome his hypermetropia, so he will need glasses for distant vision as well as near.

When testing distant vision, one must remember that the patient may be using accommodation, so one tries putting on convex glasses,

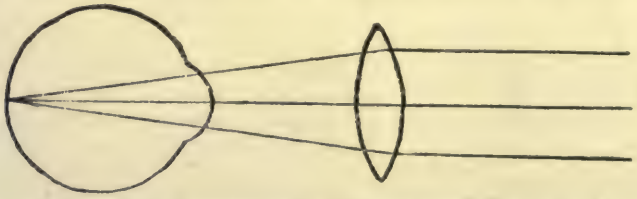


FIG. 81.—SHOWING THE CORRECTION OF HYPERMETROPIA WITH A CONVEX LENS.

Note that the rays are made to converge before entering the eye.

(Mayou, "Diseases of the Eye.")

the highest taken giving the measure of the hypermetropia. But in young people this will only be the *manifest hypermetropia*, and a certain portion, known as the *latent hypermetropia*, will only reveal itself under a mydriatic. In children the latent is often greater than the manifest, but in adult life it gets less, and finally disappears, the whole hypermetropia present being manifest. In young people as a rule one gives glasses which correct the manifest and half the latent hypermetropia, while in adults the total hypermetropia is generally corrected. If distant vision is not normal with any glass, and there are no defects in the media or fundus, one must test for astigmatism.

Myopia is an error of refraction in which the eye is lengthened antero-posteriorly, and becomes egg-shaped. Parallel rays come to a focus before reaching the retina, and no effort of the myope can alter this, so all images of distant objects are blurred. The blurring can be made less by nearly closing the lids, and so making the pencil of rays smaller; hence the habit of "screwing up the eyes" seen in myopes. While rays from a distant point can only be brought to a focus on the retina by means of a concave glass, rays from a near point may come to a focus, and the farthest point from which they can be focussed is the "far point" of the eye and the measure of the myopia.

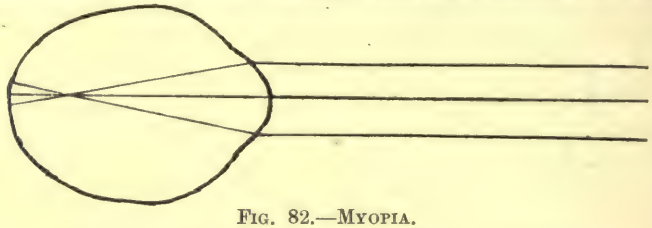


FIG. 82.—MYOPIA.

The rays come to a focus before falling on the retina.
(Mayou, "Diseases of the Eye.")

If the "far point" is a metre off, the myopia is 1 D; if $\frac{1}{2}$ metre it is 2 D; if only 5 centimetres it is 20 D. The myopia can also be measured by the lens needed to focus distant objects, which would be -1 D, -2 D, and -20 D, in these three instances.

The near point is moved towards the eye just the same as the "far point," measuring by diopters, so that a man of forty-five, who has normally 3·5 D of accommodation, will, if he has 2 D of myopia, have a "near point" the same as a normal person with 5·5 D of accommodation, or 18 centimetres.

Causes.—The prevalence of myopia in a community corresponds to the prevalent standards of education. It is seldom seen in savage

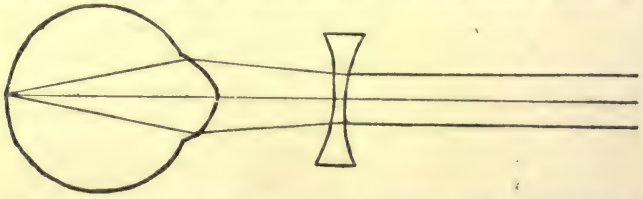


FIG. 83.—SHOWING THE CORRECTION OF MYOPIA WITH A CONCAVE LENS.

Note the rays are made to diverge before entering the eye by means of the concave lens.
(Mayou, "Diseases of the Eye.")

races, and is more and more frequent as the eyes are more used for near work. It is never congenital, but appears usually at eight or twelve years of age, increases up to twenty or twenty-five, and then remains stationary. The higher degrees are not simply an error of refraction, but a disease due to degenerative changes, with softening and bulging at the posterior part of the eye—*posterior staphyloma*. There are generally changes in the choroid also, and no glasses will bring vision up to normal. Such cases are known as *malignant myopia*, and may run as high as 30 D.

Detachment of the retina is four times as frequent in myopes as in normal persons, not usually appearing before middle life. Heredity is strongly marked in high myopia.

Treatment.—After examination as above detailed, glasses are ordered. In young people with moderate or low myopia, the defect should be fully corrected, and the glasses worn all the time. Older people will be more comfortable with full correction for general wear, and 2 or 3 D less for near work. In high myopia such glasses are ordered as can be worn with comfort; for instance, −8 or −10 D is often as high as will be worn with comfort by a person with 20 D myopia, partly because of the troublesome prismatic effect of strong glasses. In young people specially it is most important to attend to general hygiene and school work, not allowing any overstrain of the eyes.

Operation is sometimes performed in cases of high myopia in young people. The lens is removed by needling or extraction, and the myopia is thus reduced by 15 or 20 D. Brilliant results are occasionally obtained, but the proceeding is not usually looked on with favour, and in any case only one eye should be operated upon.

Astigmatism is an error of refraction caused by the refracting surfaces not being spherical, but more curved in one meridian than another. The two meridians differing most are nearly always at right angles, and more often than not they are vertical and horizontal, the vertical being the more myopic, and the horizontal the more hypermetropic. Though the cornea is chiefly at fault, the lens may share in the error.

If one meridian is normal, the astigmatism is called *simple*—either *simple hypermetropic* or *simple myopic*, according to the fault in the other meridian. If both meridians are at fault, one more than the other, but both hypermetropic or both myopic, it is called *compound hypermetropic* or *compound myopic astigmatism;* while if one meridian is hypermetropic and the other myopic, it is *mixed astigmatism*. Such astigmatism is a congenital defect, and does not change much during life. *Irregular astigmatism* is caused by corneal disease, and is generally accompanied by corneal opacities.

In astigmatism no object, either near or far, can be brought to a focus on the retina, as no effort of the eye can overcome the defect.

Symptoms.—These vary according to the degree, but speaking generally are those of hypermetropia, but more severe. *Headache* is specially common, and is not in proportion to the defect, being more frequent with low than with high degrees of error. On examination of the sight it is found subnormal, and no spherical lens brings it up to normal. On examination by the shadow test it is found that the correcting glass is not the same in all directions, and the difference between the highest and lowest meridians will be the measure of the astigmatism. This is corrected by a cylindrical glass in which the curvature is in one direction only, the other or plane meridian being the axis. In the great majority of cases the correcting cylinder has its axis vertical, or nearly so, in hypermetropic astigmatism, and horizontal, or nearly so, in myopic astigmatism; the faulty curvature of the eye and the curvature of the correcting cylinder both being at right angles to the axis of the cylinder. The astigmatism may amount to 5 D, but rarely more. After an objective examination by the shadow test, a subjective examination with glasses is made. The correcting glasses, specially if strong, are often uncomfortable at first,

and the patient should be warned that it may be several weeks before he gets accustomed to them.

THE OCULAR MUSCLES.

The eyeballs are kept in place, and normally directed straight forwards at rest, by the tonic contraction of the orbital muscles, six for each eye—four *recti* and two *oblique*. If any one of these is affected, its loss will be shown by defective movement, and naturally it will be most missed when it is called upon to act, and fails to do so. The defective movement may be obvious if great, but if slight it may only be shown by the presence of double sight, or *diplopia*. The commonest cause of diplopia is paralysis of one or more orbital muscles. If only one, it is generally the *superior oblique* or *external rectus*, as each of these has a special nerve, the fourth and sixth respectively. When the third nerve is affected, a whole group of muscles fails to act. The commonest cause of such paralysis is syphilis affecting the nucleus of the nerve, but injury or disease at the base of the brain, inflammation in a neighbouring nasal sinus, diphtheria, tabes dorsalis, and probably cold in the peripheral distribution of the nerve, may all cause it.

Ophthalmoplegia, paralysis of the third nerve in whole or part, is common. If the external muscles only are affected (*ophthalmoplegia externa*), there will be drooping of the lid, and the eye will be turned down and out by the uncontrolled action of the superior oblique and external rectus. If the internal muscles only are affected (*ophthalmoplegia interna*), the pupil is dilated and accommodation paralyzed; this is rare except as the effect of atropine or other mydriatic. Both branches of the third nerve may be affected, when both sets of symptoms are combined (*ophthalmoplegia totalis*).

In paralysis of the fourth nerve there is diplopia in the lower half of the field of vision, and in paralysis of the sixth, which is much commoner, there is internal squint, with inability to move the eye outwards beyond the middle line, and diplopia getting worse when an effort is made to look towards the side of the paralyzed muscle. This, and the fact that it appears suddenly, generally in an adult, and that vision is not defective, distinguish it from convergent squint, which is seen chiefly in children with defective sight.

Prognosis.—If paralysis comes on slowly, one muscle after another being affected, it is probably due to central degeneration, and is incurable. If the onset is sudden, it often disappears, but cases that appear and disappear repeatedly may be premonitory of tabes, disseminated sclerosis, or general paralysis. Iodide of potash should be tried.

Nystagmus is an affection characterized by short, sharp, regular oscillations of the globe, most often in the horizontal meridian. It is oftenest seen in congenitally defective eyes, as in albinos. Occasionally it is seen as the result of a peculiar eyestrain in coal-miners—miner's nystagmus—occasionally as an early sign in disseminated sclerosis and diseases of the semicircular canals.

Squint or **Strabismus** is a deviation of one eye from the normal, and is distinguished from paralysis by the fact that it persists no matter

in what direction the patient looks. Diplopia is not generally present. Squint may be *convergent* or *divergent*, the former being about a hundred times as common as the latter; it may be *constant*, *occasional*, or *alternating* between the two eyes.

Cause.—In over 95 per cent. of cases there is some error of refraction, nearly always hypermetropia or hypermetropic astigmatism with convergent squint; and myopia or myopic astigmatism with divergent squint very commonly, though not so constantly. Generally the vision of the squinting eye is worse than that of the other, owing to congenital defect or corneal opacity. There are three theories of its causation:

1. That it is due to muscular imbalance, one rectus muscle being too strong for the other.

2. That it is due to the effort of the hypermetrope to overcome his hypermetropia by the use of his accommodation, when, owing to the close association between accommodation and convergence, he converges also. But not needing convergence, he fixes the object he wishes to see with the better eye, and lets the other turn in.

FIG. 84.—MADDOX ROD.
(Mayou, "Diseases of the Eye.")

3. That there is a failure in the development of the fusion sense. Probably more than one of these causes may be present in any case.

Treatment should always be non-operative at first. Glasses to correct the error of refraction are ordered, and the better eye covered up for several hours a day to exercise the squinting eye. In children it is often well to keep the accommodation paralyzed by weak atropine drops for some months.

This treatment should be maintained for at least six months, and then, if not sufficient to bring about a cure, the question of operation may be considered. Either a tenotomy may be done on the internal rectus of the (convergent) squinting eye, or the external rectus advanced, or in extreme cases both operations done. In external squint the internal rectus is generally advanced. A permanent and satisfactory result is not attained in squint operations unless binocular vision is restored, which should be cultivated by a stereoscope both before and after operation.

THE FIELD OF VISION.

The field of vision is the area seen when the visual axis is directed to a fixed point straight forwards. When both eyes are used, the fields overlap, forming the binocular field. The field for white is a little more extensive than that for colours, the peripheral parts of the retina being less sensitive for colours than for white. Alterations in the normal field may occur from disease of the retina, nerve, or brain, and such alterations are often of great importance in localizing the site of a lesion. The commonest alterations are—

1. **Scotoma,** which is a blind area in an otherwise normal field, often occurring symmetrically in both eyes, as seen in toxic amblyopia. Sometimes the blindness is for colours only, white objects being seen, and this is known as a "relative scotoma." Scotomata are frequently seen in disseminated sclerosis.

2. **Contraction** or **Narrowing** of the field, affecting both eyes, is seen in early optic atrophy, in glaucoma, and other conditions. Vision may remain normal in the centre of the field, while the field is greatly narrowed at the periphery, specially for colours. Alterations of the field are often seen in hysteria and neurasthenia, but are irregular, and vary from day to day.

3. **Hemianopia** is a defect in which half of each field is lost. If it is the two right halves or two left halves, it is *homonymous hemianopia;* but if the two nasal or two temporal halves, it is *heteronymous* or *crossed.* (See Fig. 78.)

Hemianopia may be tested for roughly by covering one eye, telling the patient to look straight forwards, and moving one's hands to the right and left, and above and below, and noting where the movements are seen. The lesion may be located by throwing a beam of light from the side into the pupil, and noting if it contracts freely. A small amount of contraction will be seen even when the light falls on the blind half of the retina, but there is generally a marked difference on the two sides, except as noted below under Homonymous Hemianopia. Complete and accurate measurement of the field can only be made with an apparatus for the purpose, known as a "perimeter."

Nasal Hemianopia is almost impossible, as it could only be caused by the outer half of each optic nerve being destroyed at the chiasma.

Temporal Hemianopia is caused by disease affecting the chiasma, where the fibres of both sides are interwoven. The retina becomes blind on both inner halves, and temporal vision is lost. The causes are various—fractures of the body of the sphenoid, tuberculous disease, hæmorrhage, exostosis, specific disease, and, perhaps oftenest of all, tumour of the pituitary gland. *Transitory recurrent temporal hemianopia* is an important sign of a *syphilitic lesion* at the base of the brain.

Horizontal Hemianopia may occasionally occur from a growth pressing on the chiasma either above or below, and probably also from symmetrical disease of the hemispheres.

Homonymous Hemianopia is due to disease affecting the optic tract behind the chiasma. It is always due to a lesion of the side of the brain opposite that of the lost half-fields, and by the aid of the pupil and other symptoms it is often possible to localize the lesion. *Wernicke's symptom* is important. In hemianopia, if the light is thrown into the

sound side of the retina, the pupil contracts; and if the light is thrown into the blind side, it will not contract if the lesion is anterior to the primary optic ganglia, but if the lesion is behind these the pupil will contract freely.

THE ORBIT.

Various diseases of the orbit have certain symptoms in common. From the formation of the parts, any swelling causes *exophthalmos*, which is most easily seen when unilateral. Much infiltration of the tissues causes immobility of the eyeball also, from interference with the orbital muscles. Redness, swelling and œdema of the lids are specially marked with inflammation of the cellular tissues of the orbit. Chemosis of the conjunctiva often occurs. Fluctuation may be present, but is not generally made out easily. Pain may be severe, and disturbance of vision may be present.

Periostitis oftenest occurs at the margin of the orbit, and may be acute or chronic; the latter is common, and often lasts for years. It may be caused by tubercle, syphilis, ethmoidal disease, or injury. It commonly leads to abscess, with formation of a sinus, and it may result in necrosis extending to the cranium, or may heal and cause entropion. The treatment is constitutional as far as possible. If pus is found, open and drain freely.

Cellulitis may be acute or chronic, and may affect one or both sides. It may resolve, but generally leads to suppuration.

Symptoms.—There is dusky swelling of the lids and cheek, chemosis, exophthalmos, pain, diplopia, and constitutional disturbance according to its severity.

Causes.—Most acute cases are caused by erysipelas, and such are often bilateral. Other cases are accounted for by nasal sinus disease, fevers, dental caries, metastasis in pyæmia and septicæmia, and in some cases no cause is apparent.

Prognosis.—Mild cases may resolve and do no harm. Severe cases with profuse suppuration may cause great destruction of the tissues of the lids, and lead to scars and ectropion, or the eye may be destroyed. A few cases end in cerebral complications, which are generally fatal.

Treatment.—Rest in bed, and cold applications at first: if they fail to check it, then hot. Free incisions and drainage as soon as pus is suspected.

Tumours of the Orbit.—These come under four heads:

1. Tumours of the tissues of the orbit, of which optic nerve tumours and cystic formations are the most common—sebaceous, serous, and dermoid. Lymphoma and sarcoma also occur, and growths in the optic nerve.

2. Tumours arising from the periosteum or bony wall, such as sarcoma, fibro-sarcoma, and exostosis.

3. Tumours arising from cavities or tissues close to the orbit. Congenital tumours, such as encephalocele and meningocele, which are rare. Nævi, lupus, or epithelioma may extend from the skin to the orbit.

Growths in the nose and accessory sinuses often invade the orbit.

4. Pulsating exophthalmos is a tumour resulting from vascular disease in the orbit, probably coming from the cranial cavity, and

affecting one or both eyes. It is generally due to aneurismal varix in the cavernous sinus, caused by traumatism. The treatment is rest in bed, iodide of potash, and ligation of the common carotid if the symptoms become urgent.

Exophthalmic Goitre.—In this the exophthalmos is generally bilateral. If it increases rapidly the cornea may become ulcerated, but unless it is so vision is not affected.

Unilateral exophthalmos may be due to blood or air in the tissues of the orbit. The former is seen in infantile scurvy, and the latter occurs in injuries.

Enophthalmos, or sinking of the eye into the orbit, may be due to—

1. Injury, followed by cicatricial contraction.
2. Paralysis of the cervical sympathetic, pointed to by contraction of the pupil in a dull light, the lid drooping, no perspiration on that side, and the pupil not affected by cocaine. Such paralysis may be due to fracture of the clavicle, cervical rib, operations on the neck, or enlarged glands or aneurism. Failure of development of the pigment (Hetrachroma iris) may occur as the result of an injury to the cervical sympathetic at birth.
3. Myxœdema, which constantly causes it.

INJURIES TO THE EYE.

Injuries to the cornea and conjunctiva by *heat* and *chemicals* are common. When the injury is superficial, a whitish film forms, which is soon thrown off, and the eye becomes normal. When it is deeper, the white film sloughs, leaving a granulating surface, which is followed by a scar, and often by entropion or ectropion, or adherence of the lids to the globe.

Treatment.—Wash the parts, and if possible neutralize any caustic chemical known to be present, using baking soda for acids and very dilute vinegar for alkalies. Then apply iced compresses and cocaine to relieve pain. Healing of such injuries is often very slow.

Foreign Bodies are oftenest found under the upper lid, just inside the edge, or on the cornea. The history often gives a clue. All suspected cases must be searched carefully, with focal illumination, as it is very easy to miss a small foreign body in the cornea. When found it is removed under cocaine, either with a mop of wool, a spud, or a needle.

Blows on the Eye are occasionally very serious, though usually the eye is well protected by the orbital walls and the lids. A simple contusion causes subconjunctival ecchymosis, or "black eye." A more severe blow may be followed by paralysis of the pupil and accommodation, by dislocation of the lens, partial or complete (pointed to by severe pain lasting some hours), or by intra-ocular hæmorrhage or œdema.

Prognosis must be guarded in all cases, as some go on to the formation of cataract, and some to gradual softening of the eyeball and complete blindness.

Treatment.—Rest in bed, in a dark room, with cold compresses to the eye.

Rupture of the Globe may be the result of a severe blow, more or less of the contents of the globe escaping. The eye is frequently lost, and if the damage is at all extensive it is better to enucleate at once.

The iris may be torn by injuries, causing partial detachment from its base, known as *irido-dialysis*. The treatment of this is rest and atropine.

Penetrating Wounds of the eye are always serious, and never to be treated lightly. If entirely in the cornea, and clean, the eye may heal with little damage, but if the lens capsule is perforated there will be traumatic cataract. If the root of the iris and the ciliary body are damaged, there is more danger, for *irido-cyclitis* may be set up, and may be followed by a similar inflammation in the other eye, which is *sympathetic ophthalmia* (*vide infra*).

If a foreign body is lodged in the eye, the consequent inflammation generally goes on to complete destruction of the eye, though occasionally a small clean object may become encysted, and remain without change for years. If the foreign body is iron or steel, an attempt should be made to remove it by the electro-magnet. If much vitreous is lost, the eye is pretty sure to deteriorate slowly.

If the wound is infected pus may form in the eye, and the whole organ swell up greatly—*panophthalmitis*. Eventually the inflammation will die down after evacuation of the pus. An eye affected with panophthalmitis should not be enucleated till all active inflammation has died down. Till then one can only watch events, keep the eye as clean as possible, and relieve pain by hot fomentations or sedatives.

Prolapsed Iris in the wound should be treated according to the time that has elapsed since the prolapse took place. If only a few hours, an attempt may be made to replace it. If this is not possible, or if a day or so has elapsed, the protruding piece should be excised, and the cut edge freed from the wound if possible.

If the wound is in the ciliary region, and the eye is quite soft and vision lost, it is better to enucleate at once. If this is not done, the eye should be cleansed carefully, dressed aseptically, and the course of events watched.

SYMPATHETIC OPHTHALMIA.

Sympathetic ophthalmia is the name given to an inflammation of the uveal tract of one eye, apparently caused by previously existing inflammation in the other eye, the latter being of traumatic origin. As generally used, it means an irido-cyclitis which is much the most common form. It is important to remember that it never arises without a similar inflammation in the exciting eye. It never appears sooner than a fortnight after the injury; and if the injured eye has been enucleated, there is no danger of sympathetic ophthalmia after a month has elapsed from the enucleation. The most dangerous wounds are ragged ones about the root of the iris, and if an eye has been so wounded, and is soft, filled with blood, and blind, it should be enucleated at once. If the vision is fairly good, an effort must be made to save it by strict asepsis, freeing the iris from the wound, and keeping it at rest with atropine. If in spite of this the eye after a fortnight still shows ciliary injection, and is tender to the touch, and if there is an increase of mononuclear leucocytes in the blood, it is wiser to advise enuclea-

tion ; if it is refused after an explanation of the danger, the onus rests on the patient or his parents.

The *onset* of sympathetic ophthalmia may be heralded by signs of irritation for some time, the eye watering, and accommodation being weak. Then ciliary injection appears, the pupil becomes filled with lymph, and the iris is bound down by adhesions, and often changed in colour; if light pressure is made on the corneal margin through the closed lids, the patient shrinks back, showing that there is marked tenderness in the ciliary region. There is an increase of the mononuclear leucocytes in the blood.

Atropine drops should be used at once, but if they do not dilate the pupil in twenty-four hours they should be stopped. Leeches near the angles of the lids, hot fomentations, salvarsan and mercury internally, iridectomy, and many other therapeutic measures, have been tried, but most frequently a clear case of sympathetic ophthalmia slowly progresses to total blindness. If the case is seen when there is irritation only, the wounded eye should be enucleated at once ; but if once sympathetic ophthalmia is well established in the sympathizing eye, the removal of the wounded eye seems to have little or no effect on the course of the inflammation, and if there is any vision in it, it may eventually be the better eye of the two.

THE EAR.

GENERAL CONSIDERATIONS.

Age.—There is a greater liability to purulent inflammation of the middle ear in childhood, and to chronic dry catarrh in adult life.

Heredity is important, a tendency to certain forms of deafness being often seen in families.

Season.—Winter and spring always show an increase of ear disease, owing to its frequent association with the catarrhal conditions of the nose and throat then prevalent.

Micro-Organisms.—It is not usually easy to ascertain the micro-organism responsible for an inflammation in the ear, as the infection is so generally mixed ; but the diplococcus of pneumonia, *Staphylococcus pyogenes aureus*, and *albus*, and streptococcus, are all frequently present, and some cases are tuberculous. The character of the inflammation, whether catarrhal or purulent, depends on the virulence of the infection and on the resisting powers of the tissues. Syphilis is not nearly so important a factor in ear as in eye disease, but it accounts for certain cases of nerve deafness in young people, coming on about the same time as interstitial keratitis in the eye. Measles, scarlatina, and influenza, account for a large proportion of the cases of chronic suppurative inflammation of the middle ear, especially in children.

GENERAL EXAMINATION.

Inspection of the ears, nose, and throat should be carried out systematically whenever a case presents itself with symptoms of trouble in one or all of these regions. They are so closely allied in function and

anatomy that no proper idea of the condition of any one can be gained without a knowledge of the condition of the others.

For examination of the ear reflected light is required, owing to the depth and narrowness of the external meatus; for examination of the nares and larynx a direct light may be used, saving the trouble, and sometimes difficulty, of focussing. This, however, should be learned, thus avoiding the necessity of changing the light in the course of a complete examination. For a general examination of the ear, nose, post-nasal space, and larynx, an ordinary laryngological mirror with a focus of 8 inches is best, though one with 4 inches focus gives a better view of the tympanic membrane. The light should always be the same, so it is usual to employ electric light, though good sunlight is quite sufficient.

FIG. 85.—POSITION OF PATIENT AND EXAMINER IN ANTERIOR RHINOSCOPY.
(Watson-Williams, "Rhinology.")

The patient should be seated upright facing the surgeon, and the lamp a little behind and to the left of the patient. The head is then turned, raised, or lowered, according to which part it is desired to examine.

The instruments required are aural and nasal speculi of various sizes, a tongue depressor, and laryngeal mirrors; a napkin to pull the tongue forward before examining the larynx should be at hand. There are now various electrical instruments for direct examination of the ear and naso-pharynx, but they are luxuries the use of which should be postponed till the student has grasped the method of using the simpler instruments. He should be very certain of what he sees, and as this can only come with long practice, every opportunity of examining patients should be taken advantage of. Great gentleness and a light hand are required, together with a good working knowledge of the anatomy of the parts.

The **History** of the case should be noted, and the onset of the trouble, whether slow or sudden.

The **Hearing** should be examined and noted, each ear separately being tried with the watch, the voice, and the tuning-fork. If deafness is present, Rinne's test with the fork is important. In normal cases a vibrating tuning-fork is heard longer when held close to the meatus than if the handle is placed on the mastoid, air conduction being better than bone conduction, and Rinne's test is said to be positive. When, however, the sound-conducting apparatus of the middle ear is diseased, we find that the fork is heard better when placed on the mastoid, bone conduction being better than air conduction, and Rinne's test negative.

Tinnitus, or noise in the ear, should be noted if present.

Pain or earache requires careful examination, as its character may point to its cause. Dental caries is a very frequent source of earache

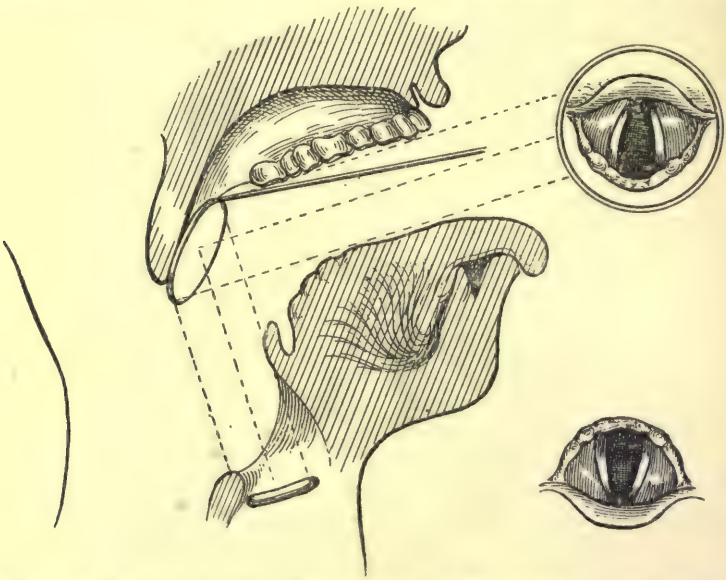


FIG. 86.—DIAGRAM SHOWING POSITION OF THE MIRROR IN LARYNGOSCOPY.

The lower image shows the actual larynx as reflected from above, to show how the image is inverted.

(Watson-Williams.)

in children, acute pain coming on oftenest at night, passing off entirely, and recurring, with little or no deafness. If the pain arises in the meatus, as from a furuncle, there will be tenderness in front of and below the ear, increased by movements of the jaw. If the pain arises from the tympanum, it will be increased by sneezing, coughing, or blowing the nose.

Discharge from the ear should be looked for. Pus in the meatus points to a perforation of the membrana tympani, even though the perforation may be difficult to see.

Vertigo may arise from the ear or from general causes, the latter being more common. Very severe vertigo, with vomiting and collapse, points to hæmorrhage into the internal ear, which is true **Menière's disease.**

Inspection of the ear will show defects in the auricle and outer part of the meatus. One requires a syringe to remove from the meatus wax, epithelium, pus, or foreign bodies, and also fine forceps, probe, and wool to cleanse it. To inflate the middle ear, a Politzer's bag or Eustachian catheter and otoscope are needed.

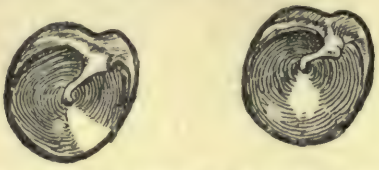


FIG. 87.—NORMAL AND DEPRESSED MEMBRANA TYMPANI (RIGHT).
(Watson-Williams, "Rhinology.")

The **Nose** and **Throat** must be examined. Naso-pharyngeal catarrh in adults, and adenoids in children, are frequent sources of ear trouble, interfering as they do with the free opening of the Eustachian tube. Nasal polypi, and spurs or other deformities in the septum nasi, are also often associated with deafenss.

THE AURICLE.

The external ear is much exposed, and frequently suffers from disease and accident. **Frostbite** and **Chilblain** are common, and easily recognized. **Eczema** is very common in children, often starting from a purulent discharge from the middle ear. The treatment is to cure the discharge if possible, and meantime to prevent its escaping from the meatus by frequent cleansing and plugging the meatus with frequently-changed absorbent wool. The affected skin is cleansed, and a simple antiseptic ointment or dusting powder applied.

Hæmatoma is almost peculiar to the auricle; it is an effusion of blood between the cartilage and perichondrium, and is probably generally traumatic. It is peculiarly frequent in the insane. It is treated by evacuation and compression.

Malignant growths are rare, the commonest being epithelioma.

EXTERNAL MEATUS.

The commonest affection of the external meatus is a collection of **Wax** or **Cerumen,** often mixed with epithelial débris. It may cause deafness only, or if it presses on the membrana tympani it may cause

FIG. 88.—PRITCHARD'S EAR SPECULUM.

tinnitus and vertigo also. It may vary in colour from yellow to black, and in consistency from the softness of butter to the hardness of a piece of wood. If fairly soft it may be syringed out at once.

but if hard it should be softened by the use of drops of sodii bicarb. (10 grains to the ounce of water), used frequently for a few days.

Foreign Bodies in the meatus are very common in children, specially beads, small buttons, and such objects. If possible, they should be removed by syringing only. In some cases it is necessary to put a bent probe or loop past the foreign body and scoop it out, but great care is needed not to injure the membrana tympani. Sometimes a foreign body may be removed by putting a splinter of matchwood dipped in seccotine or some similar cement against it, and leaving it till the cement hardens, when the wood acts as a handle by which it can be drawn out.

Boil or **Furuncle** often arises in the external meatus without known cause, or it may be due to infection from a chronic discharge. It is often multiple, causing a diffuse swelling almost closing the meatus, intensely tender to the touch, and very painful, specially on moving the jaw. It is usually due to a local infection by the *Staphylococcus albus* or *aureus*. The treatment is to cleanse and make a free incision right through the boil. This should be done with a small and exceedingly sharp knife, as the pressure of an ordinary scalpel is most painful.

Diffuse Inflammation of the meatus seems to arise from the same causes as boils, and is not easily distinguished from a crop of them. If no pointed swelling is seen to be opened with the knife, the meatus must be kept clean by syringeing with hot boric lotion, and pain may be relieved by instilling a few drops of a solution of cocaine and carbolic acid in water, 10 per cent. of each.

Eczema often affects the external meatus, and causes great irritation by the presence of dry scales. These should be syringed out with a warm alkaline lotion, and the meatus swabbed with a solution of argent. nit. in spt. æth. nit. (10 grains to the ounce).

Exostosis is occasionally seen in the bony portion of the meatus, as a swelling, generally rounded, looking like a pea under the skin, which is stretched and pale over it, not inflamed. It is very hard to the touch, and not tender. It may be single or multiple, and does no harm unless it narrows the meatus so as to risk closing it. It is most often seen in persons who have bathed and dived a great deal. If removal is called for, the base is drilled through with a dental burr, and then the exostosis chipped off with a small chisel. Great care is needed to avoid injury to the membrana tympani, and also to render the operation as far as possible aseptic.

MIDDLE-EAR DISEASE.

Pain in the middle ear is very common, specially in children. It may arise from a transient inflammation of the membrana tympani due to cold, or more often it is a reflex pain from the teeth. A safe and simple means of relieving it is glycerine and carbolic drops, about 20 grains to the ounce, to be warmed in a teaspoon, and a few drops instilled into the ear.

Clinically inflammation of the middle ear is divided into—(1) *Suppurative* and *Non-Suppurative*, and (2) *Acute* and *Chronic*.

The importance of middle-ear disease is due to the fact that, not only may it cause deafness, but it may spread to the internal ear or cranial cavity. Disease begins in the mucous membrane, and to understand the symptoms one must remember that this mucous

membrane lines a small cavity with mobile structures in it. Catarrh, if it lasts long, may interfere with the mobility of these, and suppuration may destroy them.

I.—Non-Suppurative Inflammation: A. Acute Catarrh.—The chief *causes predisposing* to acute catarrh are, in children, the presence of adenoids, and in adults sinusitis. Infection leads to blocking of the mouth of the Eustachian tube, and consequently retained secretion. In this secretion micro-organisms increase, and find their way up the tube into the middle ear, particularly in an unhealthy tube. The mucous membrane lining the middle ear becomes swollen, and the cavity more or less filled with serous exudation mixed with epithelial cells, micro-organisms, and mucus. As the oxygen in the air is absorbed, and the tube is closed, the pressure becomes lower than the ordinary atmospheric pressure, and the

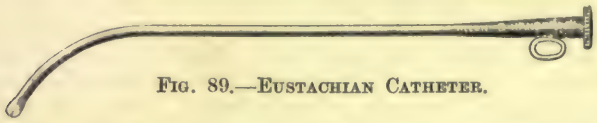


FIG. 89.—EUSTACHIAN CATHETER.

tympanic membrane is depressed by the outside air. There is deafness, a feeling of fulness or pain in the ear, and probably tinnitus. There may be occasional crackling felt in the ear, with sudden improvement in hearing, as some air finds its way in through the tube. On examination the membrane is seen to be injected and depressed, the handle of the malleus standing out too prominently.

The prognosis depends upon the time it has lasted. If the conditions causing it are temporary or easily removed, and if good hearing is restored by the use of Politzer's bag or catheter, good hearing may be regained. But if the cause is not removed, repeated attacks will probably lead to chronic catarrh and much deafness.

FIG. 90.—POLITZER'S BAG.

Treatment.—The cause, if found, is to be treated first, then the middle ear inflated daily, or three times a week, as long as the deafness lasts. If there is pain, counter-irritation over the mastoid will often relieve it.

B. Chronic Catarrh.—This is exceedingly common and important. It may follow on acute or may arise spontaneously. If the exudation in the tissues of the middle ear does not disappear, fibrous changes may occur, and the ossicles become fixed. On inspection the tympanic membrane is seen to be puckered, depressed, and its normal lustre lost.

The symptoms may not be noticed at first, as their onset is often

very gradual. Both ears are generally affected, though often one more than the other. There is deafness, getting better and worse, but on the whole increasing, specially in winter. Tinnitus and vertigo (known as Menière's symptoms) often occur. It may occur at any age, but is specially common in young adults. In the early stages, before the disease has affected the internal ear, as it commonly does eventually, a vibrating tuning-fork is heard longer if held on the mastoid than if held close to the meatus ; that is, Rinne's test is negative (see p. 456), showing that the fault lies mainly in the sound-conducting apparatus. In the early stages, also, there is often much

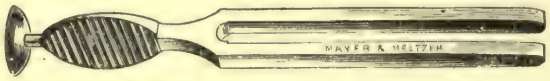


Fig. 91.—Tuning-Fork.

obstruction of the Eustachian tubes, and hearing is improved temporarily by the use of Politzer's bag, but in old cases this is often ineffective.

Treatment.—In the early stages great improvement is often brought about by regular inflation of the middle ear, either with Politzer's bag or, better still, by bag and catheter. This should be repeated two or three times a week for several weeks. If any nasal obstruction is present, it should be removed, and many cases benefit by the daily use of a nasal douche. Internally, small doses of strychnine are often of benefit. To relieve the tinnitus one may give full doses of ammoniated tincture of valerian, or bromides and hydrobromic acid, and blisters over the mastoid should be tried. A change to a dry climate will often do more than any medication.

Otosclerosis is a form of deafness which has till lately been included under the head of "chronic catarrh." In it, however, the tympanic membrane is not dull or depressed, but is normal or merely thin-looking. The mucous membrane of the nose and throat is dry and red ; air goes freely into the middle ear when Politzer's bag is used, but this does not relieve the deafness, and tinnitus is often very severe.

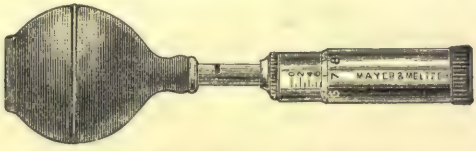


Fig. 92.—Galton's Whistle.

The pathology is not well understood, but it is often part of a general sclerosis of the submucous tissue, depending upon inherited syphilis. Treatment is unsatisfactory, but catheterization should be tried, and iodide of potash, strychnine, and phosphorus, internally.

II.—A. Acute Suppurative Inflammation of the Middle Ear.—Acute suppuration of the ear is most often the result of acute febrile disease. Among predisposing causes, the most important are adenoids, enlarged tonsils, and nasal disease.

Symptoms.—Acute pain in the ear and over the side of the head, increased on pressure over the mastoid or on moving the auricle, and

deafness, are the most prominent symptoms. In young children attention may be drawn to the ear by the child putting its hand up to the ear, while it is crying and restless. The temperature is generally raised. If it is possible to examine the tympanic membrane, it will be seen to be intensely injected, and perhaps bulging outwards, with pus in the tympanum. If seen in this stage, the tympanic membrane should be perforated by the surgeon at its lower part. This relieves pain, and gives drainage in the best position. Perforation, either spontaneous or by the surgeon, gives ease. At first the discharge is serous mixed with blood, then muco-purulent or purulent. It may stop spontaneously in a few days or weeks, or may go on for years.

Prognosis is good if treatment is begun early, except in tuberculous patients, in whom the onset is apt to be less acute and less painful. If the discharge is cleaned away and the membrane examined, the perforation is generally easily seen. If the discharge is soon stopped, the perforation may heal and no bad result follow; but if the discharge persists and becomes chronic, any of the complications described in the next section may follow.

Treatment.—The meatus should be carefully syringed out with some warm and non-irritating antiseptic lotion, and then packed with iodoform gauze, and this repeated daily. Frequently with this treatment the discharge will cease and the perforation heal, but, on the other hand, with virulent infection, or in patients with low resisting powers, the discharge becomes chronic, and various serious results may follow.

B. Chronic Suppurative Inflammation of the Middle Ear.—This affection, often called simply **Chronic Otorrhœa,** is both common and dangerous; it is dangerous both to life and hearing, though often looked upon very lightly. It generally arises from an acute inflammation, rarely coming on gradually without acute symptoms. When established, symptoms in quiescent cases are mainly discharge, and perhaps deafness, though the latter may not occur for a long time, and may not be marked. If the perforation cannot be seen, and there is doubt about the discharge, inflating the ear with Politzer's bag should settle the question, for the air is heard rushing or whistling out through the perforation, and perhaps pus may come out with it. Often the discharge dries up for a time, leaving the perforation unhealed, and comes on again when the patient gets a fresh cold. In such cases the perforation becomes gradually wider, till eventually the whole tympanic membrane may have sloughed away, and the ossicles also disappeared, leaving only the stump of the malleus above. This condition may persist throughout a long life, or complications may arise at any time.

Treatment.—The first necessity is thorough and regular cleansing of the meatus with the syringe and a warm antiseptic lotion. This should be followed by the use of some drops. In recent cases, with profuse discharge, zinc. sulphat. and acid. carbol., 5 grains of each to an ounce of water, does very well; while in older cases, where the discharge is scanty and hard to move, peroxide of hydrogen is often better. If granulation tissue appears, or if the discharge is very foul-smelling, it is a sign that the inflammation is spreading to the bone, and a stronger antiseptic should be used, such as hydrarg. perchlor. in spt. vini rect. (1 in 8,000).

Sometimes the granulation tissue will take the form of a polypus, but this is not to be looked upon as a separate thing, but simply like granulation tissue anywhere else. It is to be carefully snared or scraped

away, under a general anæsthetic if necessary, and the suppuration treated.

COMPLICATIONS.

Mastoid Disease is much the most serious complication, and may arise at any time, though very seldom in an acute suppuration. It is generally the result of a chronic otorrhœa, where the mastoid cells have been affected for some time. The temperature rises, there is often severe pain, and marked swelling behind the affected ear, causing it to stand out from the head much more than the other. Sometimes an abscess forms under the periosteum or under the skin on the mastoid bone, and when this is opened a sinus is found leading down to carious bone. If the mastoid cells and antrum are not opened and drained freely, by trephining or cutting through the mastoid bone into them, the pus may find its way into the cranial cavity, and there cause septic meningitis, thrombosis of the lateral sinus, or an abscess on or in the brain.

Treatment.—There are various ways of dealing with the mastoid antrum and cells. In acute cases occurring in young children it is sometimes sufficient to make a deep curved incision (Wilde's) behind the ear over the mastoid bone, and evacuate all pus under the periosteum. In chronic cases and in adults the mastoid antrum and cells may be opened and drained. This frequently proves sufficient, and preserves the function of hearing. The objection to this method of treatment is the length of time before the discharge stops and the possible risk of not taking away all the diseased bone. A modification of the usual method of draining the mastoid antrum is to close the posterior wound almost entirely, and to provide drainage through the external meatus by making an aperture through the membranous meatus, and passing a drainage-tube through it into the antrum, thus avoiding a discharging sinus. The complete tympano-mastoid operation is required when there are intracranial complications—where there is cholesteatomata in the antrum, this, however, is not an invariable rule—and when draining the antrum has not cured the condition. A good deal has to be decided at the time of the operation when the condition of things is seen. It should, however, always be borne in mind that if the tympanum is not interfered with, hearing will remain, while if it is cleared out deafness will be the result. When, therefore, it can be done with safety, the tympanum should be left intact.

Meningitis is indicated by rapid pulse, temperature very high, restlessness, delirium, hyperæsthesia of the organs of sense, headache, and may be optic neuritis.

Thrombosis of the lateral sinus is indicated by headache, often localized over the parietal bone, rapid changes of temperature, rigors, diarrhœa in most cases, and some slowness of comprehension.

Abscess may be in any part of the brain, but is oftenest near the necrosed bone by which the infection has entered. It is indicated by weakness, loss of appetite, foul tongue, temperature occasionally rising very high, with a slow pulse, headache generally localized, nausea and vomiting, vertigo, and marked disturbance of cerebral functions.

Great difficulty in diagnosis may occur when more than one of these complications is present, as is not infrequently the case.

DISEASES OF THE INTERNAL EAR AND NERVE.

Many cases of deafness are due to disease of the internal ear, but post-mortem examinations are few and difficult, and so the exact nature of the disease is often obscure. It is, however, generally possible to distinguish disease of the sound-perceiving apparatus (the internal ear) from disease of the sound-conducting apparatus (the middle ear). In the former there is a diminution of bone conduction (see p. 456), superiority of aerial conduction over bone conduction, and lowering of the upper tone limit, as tested with a Galton's whistle.

Cause.—The commonest cause of disease of the internal ear and nerve is long-standing disease of the middle ear, and next to this is syphilis, generally inherited. Acute suppurative inflammation of the middle ear may extend directly to the labyrinth, but this is rare. Meningitis, cerebro-spinal meningitis, brain tumours, and abscess, may injure or destroy hearing. Falls on the head, or loud noises, either single, as in explosions, or repeated, as in boiler-making, may do the same; and certain drugs, such as quinine and the salicylates, may injure it.

Symptoms.—1. *Deafness* is likely to be either slight or very grave, unless the middle ear also is affected, when it may be of any degree. When the labyrinth is affected, there is generally marked deafness for high notes.

2. *Vertigo* is often a symptom in nerve deafness. When very sudden and severe, with complete deafness, vomiting, and general collapse, it indicates hæmorrhage into the labyrinth, which is true Menière's disease. When this group of symptoms appears in a less marked form they are described as "Menière's symptoms," and probably indicate disease of the labyrinth without sudden hæmorrhage. It is thus that congenital syphilis often affects the internal ear, coming on with sudden deafness and other symptoms of labyrinthine disease, but not so profound as in Menière's disease. The youth of the patient, and the presence of other signs of syphilis, aid in the diagnosis.

3. *Tinnitus*, subjective noise in the ear, is common both in middle and internal ear disease, being generally severe and persistent in the latter. It is worse at night and when listened to.

Treatment.—The more marked cases of disease of the internal ear are usually quite unaffected by treatment. If the middle ear is affected also, treatment should be directed to it. If syphilis or any other constitutional disease is present, it should of course be treated. If Menière's symptoms appear in a severe form, leeches or blisters on the mastoid should be tried, with rest and purgatives. In other cases strychnine and iodide of potash should each be given a trial.

Deaf-Mutism may be congenital or acquired. In the United Kingdom there are about equal numbers of each. The acquired form is due to some disease, generally meningitis, scarlatina, or measles, causing deafness before about seven years of age. When deafness comes on after seven, the power of speech is not likely to be lost. Syphilis may cause either congenital or acquired deaf-mutism. The congenital form is most often due to consanguinity, and not infrequently deaf-mutes are defective in other ways, 2 to 3 per cent. being idiots.

Pathology.—There are generally changes in the internal ear, both in congenital and acquired deaf-mutism. The former may be due to intra-uterine diseases or to arrest in development.

INJURIES TO THE EAR.

Rupture of the Tympanic Membrane is a frequent accident. It may be due to a sharp instrument pushed into the ear, such as a pin used to remove wax, or to a blow on the ear, or violent concussion close to it. The pressure of water when diving may cause it. It may occur as a complication of a fracture of the base of the skull. In uncomplicated rupture the deafness is not generally marked, and soon passes off, and the membrane heals in a few days if kept clean and not interfered with. Persistent and marked deafness, with vomiting, points to more serious injury, involving the inner ear.

Concussion.—Occasionally deafness is produced by severe concussion, without any injury to the tympanic membrane. In some such cases there are symptoms indicating hæmorrhage into the labyrinth. In others the deafness seems to be due to shock, and passes off completely. In the former cases injections of pilocarpine should be tried, given daily for a fortnight, but the prognosis is bad.

THE NOSE AND THROAT.

THE NOSE.

The cavities of the nose, being lined with mucous membrane, are liable to the same catarrhal affections as other mucous membranes.

Simple Rhinitis (cold in the head), acute and chronic, is too well known to need description, and seldom calls for special treatment; but if it does a simple alkaline douche, or an oily spray containing a few grains of menthol to the ounce, with some eucalyptol and terebene, may be ordered.

Fig. 93.—Nasal Speculum.

Purulent Rhinitis results from more severe infection, usually in children, from some specific infection, as in the exanthemata. The nostrils may be quite blocked by hard crusts, and the alæ red and swollen, and there is a thin, fœtid discharge. Syphilitic infants are often affected, and on account of the blocking of the nostrils can only drink with difficulty.

Treatment.—The nostrils should be cleansed several times a day with a warm alkaline and antiseptic solution, best used with a small rubber bulb syringe. No force must be used, or the fluid may enter the middle ear. If any constitutional disease is present, of course it must be treated.

Diphtheritic Rhinitis is a form of membranous rhinitis, sometimes with, often without, marked constitutional symptoms. The diagnosis must be confirmed by bacteriological examination of the discharge. The treatment is the same as for purulent rhinitis locally, with antitoxin treatment for the general affection. The not unusual absence of general symptoms beyond those of a slight cold with malaise are misleading, and epidemics of diphtheria may result from the patient acting as a highly infectious "carrier," even if well enough to go to school. Diphtheritic rhinitis or nasal diphtheria as a complication of faucial diphtheria indicates a severe infection, and is rapidly fatal unless quickly brought under control by antitoxin.

Hay Fever is a transient simple rhinitis with paroxysmal sneezing set up by the irritation of the pollen of certain plants, specially grasses. It occurs only at the time of year when these plants are ripe, and causes great distress in persons subject to it. Such persons are frequently more or less neurotic. Some local predisposing condition in the nose, such as hypertrophic rhinitis or a deviation of the septum, may coexist.

Treatment consists in the use of a sedative spray, or galvano-cauterization, when the attack comes on, and treatment of the nasal cause, if such can be found, after the attack passes off, as otherwise it is pretty sure to recur the following year.

Hypertrophic Rhinitis is a chronic inflammation of the mucous membrane and submucous tissue, leading to hypertrophy of the parts affected, which are generally the turbinated bodies, and specially the inferior. It often affects one end only, leading to blocking of the nostrils by the greatly enlarged anterior or posterior ends.

The **Symptoms** are nasal obstruction, varying in degree at different times of the day, and often worse at night, and occasionally headache. Spraying or brushing the mucous membrane with 2 per cent. solution of cocaine causes the engorged vessels to contract and the submucous tissue to shrink, leaving the nostrils quite patent.

Treatment.—Douches and sprays are useless to cure the complaint. Free application of the galvano-cautery to the cocainized membrane is generally sufficient to give relief, but if not sufficient some of the hypertrophied membrane may be removed by scissors and snare. As little as possible should be removed, as the hypertrophied membrane has a tendency to shrink eventually, leading to a condition known as **atrophic rhinitis,** where the nasal passages are much too free, and air passes in without being warmed and moistened. This leads to laryngeal troubles.

Polypus is very common in the nostrils, arising from the mucous membrane, specially of the middle turbinated. Sometimes it accompanies suppuration in one or several of the accessory cavities; at other times it arises without obvious cause, generally affecting both sides. The polypi slowly increase till they block the nostril with pearl-grey, semi-transparent growths. They are best removed with the snare, assisted with cutting forceps, care being taken to remove all, both large and small, together with the infected bone from which they grow.

Malignant Growths in the nose are not very uncommon; they generally arise either in the accessory sinuses or on the septum.

Occasionally polypi which have recurred for years become sarcomatous Any growth in the nose which bleeds and causes a fœtid discharge is suspicious, and should be examined microscopically. Pain does not generally occur till the disease is advanced. Free removal, whenever possible, should be carried out as soon as possible.

Foreign Bodies are often found in the nostril in children, who have put them in for mischief. They can generally be easily removed with forceps or a hooked probe, when the tissues have been reduced and rendered insensitive by cocaine.

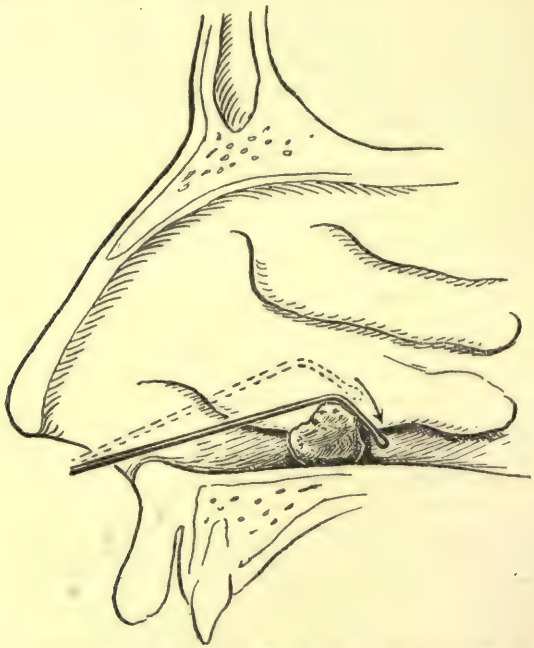


Fig. 94.—Removal of Foreign Body in Nose by a Bent Probe.

Epistaxis, or **Nasal Hæmorrhage,** is common and often troublesome. It may occur without obvious cause, or with various constitutional affections which raise the blood-pressure, or with local disease or injury in the nose. It is frequently troublesome after intranasal operations.

Much the commonest source of the bleeding is the anterior portion of the septum, easily seen on examination. There are often small dilated veins here.

Treatment.—If the patient sits upright in a cool room, and loosens the clothing round his neck, bleeding will often cease. If it does not, a few drops of solution of peroxide of hydrogen squirted into the nostril may be sufficient, or if not the nostril must be plugged. This is best done with plugs of absorbent wool soaked in peroxide, or with small firm wads of aseptic gauze. Such packing must be carefully and slowly removed in twenty-four hours, as plugs left in longer are apt to become septic. If not very carefully removed, bleeding may start again.

In cases of recurrent hæmorrhage from the septum, the part should

be painted daily with an ointment of gallic acid, 10 grains to an ounce of vaseline, or lightly touched once or twice with the galvano-cautery.

THE SEPTUM.

The septum is rarely quite straight and evenly placed, but generally shows some irregularity or twist, and if such is sufficient to block the nostril it may require treatment. Operations to correct deformities in the septum are difficult and tedious, as, whatever may be removed from the cartilaginous or bony parts, it is necessary to preserve the mucous membrane, which is reflected at the beginning of the operation and replaced at its close. This is known as the "submucous method."

FIG. 95.—ABSCESS OF THE NASAL SEPTUM SHOWING BILATERAL SWELLING.

Perforation of the Septum is most frequently the result of specific rhinitis. It also occurs from simple ulcers of the septum, and occasionally after operation, when the mucous membrane has been damaged and has sloughed. It often causes no trouble, beyond a tendency for crusts to form at the edges, which may be removed by an alkaline douche. If necessary, the perforation, if not too large, may be closed by a plastic operation on the mucous membrane.

Abscess sometimes occurs without obvious cause. When opened it generally quickly heals.

ACCESSORY SINUSES OF THE NOSE.

Accessory to the nostrils, and opening into them, are certain sinuses or hollow chambers in the bones of the skull. These are the maxillary antra or sinuses, the anterior and posterior ethmoidal cells, the frontal sinuses, and the sphenoidal sinus. They are all lined with mucous membrane continuous with that of the nose, and are liable to be affected by any form of rhinitis. They vary greatly in size and shape, and frequently drainage is not very free from them, so that products of inflammation may be retained and cause suppuration. Such suppuration is generally chronic, and only gives rise to acute symptoms if the exit for drainage should become blocked by swelling. Inflammation easily spreads from the mucous membrane to the thin bony walls of the sinuses, and necrosis with further suppuration follows. One sinus is seldom diseased alone, but several are affected, and they tend to fall into two groups separated by the attachment of the middle turbinated bone—viz., the anterior group and the posterior.

The first group comprises the maxillary antrum, the anterior ethmoidal, and the frontal cells, and pus from these is generally discharged towards the anterior nares.

The second group comprises the posterior ethmoidal cells and the sphenoidal sinus, and the pus from these finds its way backwards into the naso-pharynx.

Inflammation of the maxillary antrum is occasionally started by dental caries, as the roots of several teeth are in close relation with it. Suppuration in the accessory sinuses may give rise to various complications, some of them very serious. The long-continued presence of pus, often swallowed, may affect the general health markedly.

Ethmoidal disease may give rise to polypi in the nose, or by extension through the orbital plate to orbital abscess, and, like frontal and sphenoidal sinusitis, occasionally extends to the cerebral cavity,

FIG. 96.—DIAGRAM TO ILLUSTRATE THE ARRANGEMENT OF THE NASAL ACCESSORY SINUSES.

The dark line indicates line of attachment of the middle turbinal. *F*, frontal sinus; *AE*, anterior, and *PE* posterior, ethmoid cells; *S*, sphenoidal sinus.

(Watson-Williams.)

causing fatal meningitis. Occasionally the sinusitis may affect the optic nerve, and sudden blindness may follow. Severe headache is common in all forms of sinus disease, and, indeed, the symptoms are so varied that in all obscure cases with head symptoms the sinuses should be carefully examined.

Transillumination is often an aid in the diagnosis of sinus disease. A small electric lamp is held in the mouth, and if the room is quite dark its light shows through the cheeks, evenly on both sides if normal, but darkened on one side if there is pus in the antrum. The lamp, shaded so as to give light in one direction only, may also be held in the inner and upper angle of the orbit in such a way as to light up the frontal bone; if there is pus in one frontal sinus, that side may be darker than the other.

Pus from the antrum and frontal sinus, and also from the anterior

ethmoidal cells, appears under the middle turbinated bone. As already said, pus from the posterior ethmoidal and sphenoidal sinuses appears in the naso-pharynx. To facilitate examination, cocaine and adrenalin are applied to the mucous membrane, causing it to shrink greatly, and leaving more space for examination and manipulation. To trace the pus to its source, it is sometimes necessary to remove the anterior part of the middle turbinated with scissors and cutting forceps, but above the middle turbinated, and in the region of the sphenoid, great care is necessary on account of the danger of opening through the thin bone into the cranial cavity. The antrum is often opened through the canine fossa or alveolus, and the frontal sinus is sometimes opened from the outside.

An exploratory puncture of the antrum is easily made with Lichtwitz's trocar, through the outer wall of the nostril close to the floor, or by the Watson-Williams antral suction syringe through the middle or inferior meatus.

THE NASO-PHARYNX AND PHARYNX.

Adenoid Vegetations or hypertrophy of the pharyngeal tonsil is an infective overgrowth of the adenoid tissue normally present in the vault

FIG. 97.—SECTION SHOWING ADENOID GROWTHS IN NASO-PHARYNX. (Zückerkandl.)

of the pharynx. This overgrowth is seldom confined to the adenoids, but generally affects the tonsils also. Practically it is a disease of childhood, occurring in the great majority of cases between two and twelve years of age, though it sometimes begins earlier or later.

The chief sign of adenoids is mouth breathing. At first this may occur at night only, but as the growths increase in size it may be by day also, and the child has a stupid, dull expression, with the mouth seeming to hang open. The voice is affected, the child speaking as if

he had a cold in his head, and often he is dull and inattentive. Deafness is a frequent complication, arising from the blocking of the Eustachian

FIG. 98.—HOW TO PALPATE FOR ADENOIDS.

tubes by the catarrh. Diagnosis is pretty certain from appearances only, but can be made quite certain by putting a finger in the naso-pharynx, when the soft mass of adenoids is felt filling the space.

FIG. 99.—ADENOID FACIES.
(Watson-Williams.)

Treatment.—If symptoms are slight, it may be sufficient to attend to the child's general health, and to give a nasal spray and order easy gymnastic exercises or Swedish drill with the mouth kept shut, so as to exercise the child in nasal respiration. If such methods fail, the adenoids should be removed. As the operation is very painful, a general anæsthetic is advisable in most cases. The growths should be removed with a curette as thoroughly as possible, as they easily recur, specially in young children. They tend to disappear spontaneously

about puberty, and are not likely to recur in children approaching that age. If enlarged tonsils are present, they may be removed at the same time as the adenoids.

Malignant Growths in the naso-pharynx are generally extensions from those arising in the nose or its accessory cavities.

Ulcers in the posterior wall of the pharynx are usually specific in origin, calling for active antisyphilitic treatment as well as local cleansing with some antiseptic douche. If neglected they may rapidly destroy large areas of tissue, resulting in serious deformities from scar tissue. The same holds good of **ulcers of the palate** and fauces, which are frequently specific, and which may perforate either the soft or hard palate. In the latter case there will, of course, be necrosis, and a very troublesome and foul condition of the mouth results. Tuberculous ulcers also occur in the palate, and perforate it, but they are not so rapidly destructive as are specific ones.

Paralysis of the Soft Palate is frequent after diphtheria ; the voice changes and becomes nasal in tone, and when fluid is swallowed some of it escapes through the nostrils. It usually disappears in a few weeks. Paralysis of the palate and pharynx occurs as an early symptom of bulbar paralysis, with similar signs. It gets better and worse, but on the whole progresses to a fatal issue.

Acute Tonsillitis, is a common and painful affection, many persons being liable to one or two attacks every winter. It is probably always due to infection either from without or from septic material present in the neighbourhood, as in the nose or mouth. It is sometimes followed by acute rheumatism or other septic trouble. The tonsils may be normal in the intervals between attacks, or may show signs of chronic inflammation, the crypts being filled with thick white exudation. The general symptoms are marked, the temperature rising to 103° F. or more, with headache and severe pain frequently. Swallowing is almost impossible, and for a day or two the patient suffers great distress. If an abscess forms in the peritonsillar tissue, it is termed a quinsy.

Treatment.—Rest in bed, with a purgative and frequent small doses of sod. salicyl. at first, and frequent washing out of the mouth with a hot antiseptic solution. If an abscess is found, it may be opened with a small guarded knife, always remembering the need of care not to wound the important vessels in the neighbourhood.

Chronic Tonsillitis, with hypertrophy of the tonsils, is exceedingly common, specially in children suffering from adenoids. The tonsils often meet in the middle line, and interfere with breathing, speaking, and swallowing.

Treatment.—In slight cases general hygienic measures, with astringent gargles or paints locally, may be tried for a few months, but severe cases are best treated by removal of most of the enlarged tonsil, either by tonsillotome, or, if this is not available, by guarded knife and scissors. Galvano-puncture is sometimes used where cutting is objected to, but it is slow and painful.

The **Uvula** is sometimes hypertrophied, so as to touch the base of the tongue and cause an irritating cough. Astringents should be tried, and, if not successful, the tip of the uvula may be snipped off with scissors after it has been painted with cocaine.

Pharyngitis, the common "sore throat," may be either acute or chronic. Many persons always develop pharyngitis as the result of cold or wet, the throat being sore and dry for a day or two, with slight constitutional symptoms and some hoarseness. More severe forms of pharyngitis accompany tonsillitis and laryngitis. **Chronic Pharyngitis** is nearly always secondary either to nasal disease or to some chronic gastric trouble. The mucous membrane is thick and congested, and there is more or less sticky secretion. In some cases the adenoid tissue present in the mucous membrane is hypertrophied, causing little swellings varying from the size of a small shot up to nearly the size of a pea. This is known as **Follicular Pharyngitis,** or clergyman's sore throat, and is usually very chronic. It is often associated with misuse of the voice, overstraining it when tired, or by speaking in the open air in cold and damp weather.

Treatment.—The most important point in the treatment is to remember, as noted above, that pharyngitis is nearly always secondary,

Fig. 100.—Lichtwitz Trocar and Cannula.

and no cure will be permanent or satisfactory that does not modify the cause. After careful attention to the conditions believed to cause it, local treatment is advisable. In acute or subacute attacks a simple antiseptic spray should be ordered, and a lozenge, such as formamint or black currant. In chronic cases the pharynx should be painted or brushed once or twice a week with 2 or 3 per cent. nitrate of silver solution, and some milder astringent should be ordered for home use, such as glycerine of tannin with a little glycerine of carbolic acid, to be brushed on the pharynx twice daily. If enlarged follicles are present, they should be touched with the galvano-cautery after being cocainized.

Malignant Disease is rare in the pharynx, but not uncommon in and about the tonsils, in which sarcoma occurs pretty often. It is frequently beyond all possibility of operation when seen, and is rapidly fatal.

Foreign Bodies are often complained of in the throat, but more often than not nothing is to be found. The complaint is not purely imaginary. No doubt the mucous membrane is often scratched when some piece of bone or other hard material is swallowed, and the patient feels as if something were sticking in the throat. The pharynx should be sprayed or painted with 2 per cent. solution of cocaine, and carefully examined with the mirror and the finger, as small pieces of fish-bone are not easily seen. If the throat is painful, gargling with hot milk gives some relief. The mucous membrane heals very quickly.

THE LARYNX.

Diseases of the larynx derive great importance from the fact that the narrow aperture of the glottis is so easily blocked, and respiration thereby hindered and life endangered. Such blocking may arise from the swelling of the parts in the various forms of laryngitis, from new growths, or from paralysis of the abducting muscles of the vocal cords.

Laryngitis occurs in many different forms, of which the most important are simple acute and chronic, tuberculous, syphilitic, and diphtheritic. In simple laryngitis the mucous membrane and submucous tissue are the parts affected, but in tuberculous and syphilitic laryngitis the cartilage of the larynx is generally involved.

Acute Laryngitis is generally the result of exposure to cold and damp, being an extension downwards of an ordinary "cold." It also occurs in many specific fevers. Loss of voice is the most prominent symptom in adults, and dyspnœa in children. If the larynx can be

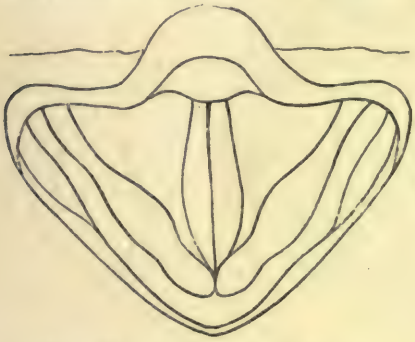


FIG. 101.—ADDUCTION OF VOCAL CORDS IN PHONATION.

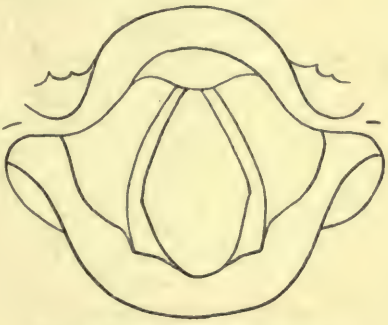


FIG. 102.—ABDUCTION OF VOCAL CORDS ON DEEP INSPIRATION.

examined, the mucous membrane is seen to be bright red and more or less swollen; the swelling may be confined to one part, oftenest about the false cords. There is more or less fever as a rule.

Treatment.—If the attack is at all sharp rest in bed should be enjoined, with the use of a bronchitis kettle. Hot or cold applications over the larynx often give relief, the choice being determined by the patient's sensations. When there is much obstruction to breathing, the swelling may be reduced by the use of a spray of adrenalin (1 in 10,000). In other cases a spray of menthol in oil is useful. If constitutional symptoms are marked, a saline aperient should be given at first, and then salicylate of soda or antipyrin.

Chronic Laryngitis is a chronic inflammation of the mucous membrane, often confined to the region of the vocal cords, and generally the only symptom is hoarseness. On examination the larynx as a whole appears normal, but the cords have lost their normal polish, and appear often a dirty yellow, with perhaps a rough look.

In many cases the origin of the disease is clearly traceable to misuse or overstrain of the voice, or to excessive smoking; but in other cases no cause can be found, and in some the laryngitis recurs every year at the same time, lasting weeks or months, and gradually disappearing.

Treatment.—If the originating trouble can be found, means should, of course, be taken to remove or mitigate it. Local treatment is important. A spray should be ordered for home use, various sedatives and astringents with antiseptics being tried, such as menthol (gr. xx.) and thymol (gr. v.) in oil ʒi., chloride of zinc, carbolic acid, etc. Once or twice a week the larynx may be swabbed out with some astringent, such as nitrate of silver (gr. x. to ʒi.) or chloride of zinc (gr. xxx. to ʒi.).

Tuberculous Laryngitis is generally, if not always, secondary to pulmonary tubercle. Probably it is a local infection from the sputum, masses of which often lie in the larynx, specially in the interarytenoid fold, which is one of the regions most commonly affected. The great majority of cases occur in fairly advanced cases of phthisis. Hoarseness and increased cough point to laryngeal trouble. On examination the mucous membrane is seen to be pale all over the larynx, and swollen or ulcerated in some parts. The most frequent changes are pear-shaped swelling in one or both arytenoid cartilages, ulceration in the interarytenoid space, swelling of the false cords, and erosion or ulceration of the edges of the vocal cords, either in part or whole. In some cases the swellings subside and the ulcers heal, even though the lung disease progresses. In others the swelling increases and spreads, further ulceration takes place, and the larynx seems on examination to be all but blocked. Pain is marked in such severe cases, specially on swallowing. The diagnosis is from malignant disease and syphilis. In malignant disease the mucous membrane is generally normal or injected, not pale, as in tuberculous disease, and the glands have more tendency to be involved. The age of the patient is generally a help. In syphilis there is also injection of the mucous membrane ; the lesions are often symmetrical on the two sides of the larynx, and there is the history to aid. Occasionally the two infections occur simultaneously, and diagnosis is exceedingly difficult.

Treatment.—After treatment of the lung disease, rest to the larynx is the first necessity. This is promoted by the use of soothing sprays or inhalations to allay the cough, and by complete rest of the voice. When ulceration occurs, the ulcer should be touched with lactic acid. In advanced cases, where swallowing becomes difficult, the insufflation of orthoform powder gives great relief.

Syphilitic Laryngitis is oftenest tertiary, though occasionally secondary. In the latter there are superficial ulcers and warts, generally symmetrical. In the tertiary form gummata occur, breaking down to form deep ulcers and widespread perichondritis. There is great hoarseness and cough. If the lesions heal under treatment, they are liable to be followed by scars and stenosis.

Treatment.—Vigorous constitutional treatment is the first requirement. A spray containing some mild astringent and antiseptic should be ordered for home use, and ulcers should be touched every second or third day with solid nitrate of silver. If stenosis occurs, intubation or tracheotomy may be called for.

Diphtheritic Laryngitis is almost always an extension of the disease from the fauces, but sometimes this may have been so slight as to be unnoticed, and attention is first called to the child's state by difficult respiration, cough, and hoarseness. The sudden onset, the symptoms

of constitutional disturbance, and the signs of inflammation about the fauces, leave no doubt about the diagnosis.

Treatment is that of the general affection, with an astringent and antiseptic spray if the patient is old enough for it to be used. If obstruction occurs, intubation or tracheotomy may be called for.

Neoplasms in the larynx are not uncommon, both innocent and malignant being seen.

Papillomata occur in children, and when removed recur again and again till puberty. They arise not only from the vocal cords, but from other parts of the larynx and from the epiglottis.

FIG. 103.—GROWTH ON LEFT VOCAL CORD, AND BELOW THE INVERTED LARYNGOSCOPIC IMAGE.

(Mackenzie, "Ear, Nose, and Throat.")

In adults, also, papillomata occur, but are not so fast-growing or numerous. They are generally the result of long-continued catarrhal inflammation or other irritation. They may be removed with laryngeal forceps under cocaine.

Malignant Growths may attack any part of the larynx, carcinoma being the commonest. On the vocal cords and false cords it often begins like a papilloma, and the diagnosis can only be made by removing a piece for examination. The glands are not affected early when the disease begins in these parts, and it proceeds slowly; but when

it begins about the rim of the glottis or about the epiglottis the glands are early affected, and progress is rapid. Rigidity of the parts and pain shooting up to the ear are both very suspicious signs.

Removal of a part or the whole of the larynx gives the only chance for cure, but in many cases the disease is too far advanced for this to be attempted, or in such a situation that it is useless, and tracheotomy is the only means of prolonging life a little.

Paralysis of one or more muscles of the larynx may give rise to aphonia, and where the abductors of the cords are paralyzed may cause dangerous dyspnœa, by the uncontrolled action of the adducting muscles pulling the cords together.

The causes of paralysis are very various, as it may arise from any central cause or from anything affecting the nerves in their course —*e.g.*, pressure of a growth or of an aneurism on the recurrent laryngeal nerve. Post-diphtheritic paralysis sometimes occurs. Paralysis of the abducting muscles first occurs from pressure on the recurrent laryngeal nerves by aneurism or neoplasm, and only after an interval are the less susceptible adductors involved.

Diagnosis can only be made by careful examination of the larynx, watching the movements of the cords when an attempt is made to use the voice.

Treatment depends on the cause, which must be treated if it can be found. Local treatment is not of much avail, except in hysterical cases, which are sometimes the result of sudden fright, and where a mild galvanic shock to the cords often results in an immediate cure.

Foreign Bodies are sometimes lodged in the larynx, and may be removed with forceps after the parts have been very thoroughly cocainized. If the attempt to do this is not successful, it may be necessary to do thyrotomy, the larynx being opened by a vertical incision through the thyroid cartilage from outside.

CHAPTER XXIII

INJURIES AND DISEASES OF THE NECK

Contusions—Fractures of bones and cartilages—Wounds—Infective conditions—Tumours—Affections of thymus and thyroid glands—Injuries and affections of the trachea—Affections of the œsophagus.

INJURIES.

Contusions.—Result from a blow or crushing force, and from throttling or hanging. In throttling the marks of the fingers can often be seen. In strangling the mark of the cord or other material used passes straight round the neck, while in hanging it is oblique, being higher behind than in front. When the contusion is due to a blow, the discoloration has a limited area, and is much less diffused than when the injury has been done by a crushing force, as when a wheel passes over the neck.

The danger of contusions of the neck lies in the pressure which may be exerted on the air-passages by extravasation of blood under the cervical fascia and by swelling of the injured parts. Emphysema of the connective tissue may be produced by rupture of the mucous membrane of the air-passages, and this may spread widely.

The **hyoid bone, thyroid** and **cervical cartilages,** and the **trachea,** may be fractured or otherwise injured in contusions of the neck. Swelling and discoloration result, and emphysema if the mucous membrane be torn. Grave interference with breathing may result, and swallowing and talking are interfered with, while fatal œdema of the glottis may be set up. If blood should enter the air-passages, there is the further risk of septic pneumonia.

Treatment.—It is frequently necessary to perform tracheotomy in order to avoid suffocation. The fractured cartilages or bone may be replaced, and the neck fitted with a poroplastic collar.

Wounds.—Any part of the neck may be injured by wounds, and these call for no special mention, except one important variety—namely, **Cut-Throat.** This may be—

Suicidal, when the wound is generally from left to right, and the injury deeper at the beginning of the cut. In left-handed people the wound may be from right to left. The vessels usually escape, since the head is thrown back, bringing the vessels under the shelter of the sterno-mastoid muscle.

Homicidal, when the wounds will vary in severity, position, and extent, but they are usually of equal depth throughout, and usually divide important vessels and structures.

Clinical Varieties.—(*a*) Those wounds which do not open the pharynx or air-passages. These call for no notice.

(*b*) Those wounds which involve the air-passages :

(i.) **Above the Hyoid Bone.**—The lingual or facial artery may be injured, the root of the tongue may be cut, and the tongue may fall backwards, producing asphyxia.

(ii.) **Thyro-hyoid Space.**—The lingual, facial, and superior thyroid vessels may be injured, the epiglottis cut, and blood find its way into the larynx.

(iii.) **At the Level of the Larynx.**—The vocal cords and thyroid gland may be injured.

(iv.) **Below the Larynx.**—The thyroid gland and vessels may be injured, the trachea may be opened, and asphyxia result from displacement of the cut ends or from bleeding into the trachea. Large vessels may be injured and lead to fatal hæmorrhage. Veins may be cut and air be sucked in. The recurrent laryngeal nerve may be cut.

After-Effects.—Septicæmia or pyæmia may be set up. Serious cellulitis, œdema of the glottis, tracheitis, bronchitis, and septic pneumonia and surgical emphysema, may result; while an aerial or pharyngeal fistula, laryngeal stenosis, and aphonia from injury of the larynx or its recurrent nerve, may follow later.

Treatment.—All bleeding should first be stopped. If the larynx has been opened, tracheotomy should be performed and the wound in the larynx closed. If the trachea is opened, a tube should be inserted and packed round with gauze. The soft tissues should be united layer by layer, and the superficial part of the wound drained. The head should be bandaged with the chin depressed, so as to relieve strain on the stitches.

Infective Conditions.

Diffuse Suppurative Cellulitis may be set up in any of the planes of the neck. The one to be most carefully noted is that which is known as "Ludwig's angina," which begins as a periadenitis in the submaxillary region, and has already been referred to under Cellulitis (Chapter VII).

Actinomycosis occurs in the neck as a diffuse swelling without pain, and slowly involves the superficial structures, becoming hard in some places, and at others breaking down, with the formation of sinuses which discharge the fungus.

Boils and **Carbuncles** are frequently met with at the back of the neck. The latter may give rise to severe constitutional symptoms, and must be actively treated by making crucial incisions, antiseptic applications, and general tonic treatment.

TUMOURS OF THE NECK.

Besides the cysts, mostly congenital in origin, and referred to under Deformities in Chapter XIV., there occur several forms of solid growths :

Lipoma—*Circumscribed.*—This usually occurs at the back of the neck or in the supraclavicular region.

Diffuse.—Begins at the back of the neck, and spreads around it. This form is not encapsulated, and it is very difficult to extirpate it, nor is it usually necessary to attempt to do so.

Fibroma.—Starts in the ligamentum nuchæ or the periosteum of a vertebra, and grows slowly. It is not easy to remove, but should be attempted when the growth is considerable in size.

Osteoma and Chondroma.—Are occasionally met with on the transverse processes of the vertebræ.

Sarcoma.—Sometimes met with springing from the fascia or connective tissue of the neck.

Carcinoma.—If primary, it is usually a squamous epithelioma in connection with the second visceral cleft, appearing under the sterno-mastoid about the level of the hyoid bone.

Endothelioma.—This is met with in the carotid gland, and is sometimes referred to as **tumour of the carotid gland.** Normally the gland is of very small size, and is situated behind the division of the common carotid; but when the seat of endothelioma it increases in size, slowly as a rule, till it encloses the carotid vessels and becomes adherent to the internal jugular vein, and may involve the nerves of the neck, especially the vagus and sympathetic. The superficial appearance of the swelling is that of a smooth, ovoid tumour lying at the level of bifurcation of the carotid. It must be distinguished from aneurism, adenoma, tuberculous glands, and malignant disease.

Treatment.—Only remove if the symptoms are urgent, as the vessels have usually to be ligatured.

THYMUS GLAND.

This structure is present in its normal size only during the early years of life, and has greatly diminished by the time puberty is reached. At times, however, the gland may become enlarged, producing symptoms of pressure on the trachea, bloodvessels, and nerves. This pressure may be exerted gradually, with occasional paroxysms, or, especially in infants, they may occur suddenly without apparent cause—**Thymic Asthma.** Such an attack may cause death during asthma. The enlargement may be part of the condition known as the **Status Lymphaticus,** in which there is a general hyperplasia of the lymphatic system.

The only **Treatment** when the gland is causing serious symptoms is to remove it.

Malignant tumour (sarcoma or carcinoma) of the thymus occurs, but is seldom diagnosed.

THYROID GLAND.

The gland may be physiologically enlarged at the menstrual periods, and also during pregnancy and in the act of parturition, the last being doubtless due to the muscular effort, since other efforts may also produce an enlargement.

Thyroiditis.—This is an acute affection, and may occur in a previously healthy gland or in one the site of goitre. The inflammation may resolve or go on to suppuration. The condition is due to pyogenic organisms which gain access by the blood-stream during acute infection and "colds." Sometimes the infection may be direct, as from a septic wound.

Signs and Symptoms.—The onset is usually sudden. There may be a rigor, pain is severe, and tension over the front of the neck marked, so that the patient bends the head to relax the strain. There is

severe headache and vertigo. The swelling is firm and elastic, the subcutaneous veins are enlarged, but the skin is usually unaffected. If the swelling is large, there may be interference with swallowing. If suppuration occurs, the usual symptoms show themselves, and the pus should be liberated and drainage established; otherwise the treatment is that for acute inflammation elsewhere.

Goitre (Bronchocele).—An inflammatory enlargement of the thyroid gland. It is peculiar to certain countries and districts, as Derbyshire, Gloucestershire, and Switzerland, and more common in women than in men. Nothing definite is known as to its causation; it has been attributed to a variety of causes, including frequent recurrence of acute inflammation, peculiarity of soil, pollution of drinking water or its deficiency in iodine. The following varieties are described:

1. **Parenchymatous Goitre.**—The secreting and fibrous parts of the gland are hypertrophied, the whole presenting a horseshoe-shaped tumour, which is soft and may be smooth or lobulated, and is asymmetrical as a rule. Sometimes the isthmus is chiefly enlarged, or an accessory lobe may be involved. This may extend behind the sternum, entering the thorax, and constitute the **intrathoracic** goitre.

If the secretory portion of the gland be chiefly enlarged, spaces are formed which are filled with a thick yellow material, **colloid goitre;** while if these spaces are large the term **cystic goitre** is applied. The tumour may then attain a very large size.

If the fibrous part of the gland be chiefly enlarged, the swelling is smaller and harder, and pressure symptoms may be marked owing to the tendency to contract. If the contraction is extreme, the secreting part of the gland may become atrophied and myxœdema be set up.

When the bloodvessels of the gland are chiefly enlarged, the term **vascular goitre** is given to the condition. The swelling pulsates, and is increased when muscular effort is made. Hæmorrhagic cysts may develop in this variety.

Signs and Symptoms.—The tumour varies in size, the skin is freely movable over it, the subcutaneous veins are enlarged. The swelling can be moved in a transverse direction, but not vertically, and it moves up and down with the larynx on swallowing, which distinguishes it from malignant disease of the gland and from an aneurism. There is shortness of breath on exertion, and the patient is liable to acute attacks of dysphonia. Pressure is sometimes exerted on the œsophagus, causing difficulty in swallowing. There may also be some disturbances of the heart's action, while pressure on the bloodvessels will give rise to a sense of fulness in the head.

Treatment.—Medicinal treatment consists in giving iodine, potassium iodide, iron and arsenic, thyroid extract, or thyrodine. If any of these are to prove of benefit, their action will be soon seen. As a rule they are of little avail, and operative procedure has to be adopted when pressure symptoms are marked, or to avoid the possibility of malignancy developing. The operation usually undertaken is to remove one-half of the gland. This may be carried out under local anæsthesia, especially when dyspnœa is a marked symptom. If there is sudden dyspnœa, it can sometimes be relieved by making an incision in the middle line, so as to divide the deep fascia or the isthmus. If this fail, tracheotomy must be performed.

The risks of the operation are cardiac insufficiency, acute thyroidism

from absorption of liberated thyroid secretion in large quantities, tetany from removal of parathyroid glands, myxœdema from removal of too much gland tissue.

2. **Adenomatous Goitre.**—This tumour is due to the growth of adenomata within the gland. The remaining portion may be normal or hypertrophied. The adenomata vary in size; some are cystic, and some solid.

The tumours or cysts should be enucleated.

FIG. 104.—ADENOMATOUS GOITRE.
(Stewart's "Surgery.")

Malignant Disease.—Sarcoma and carcinoma may develop in a gland which has been the seat of goitre, or in a previously healthy one.

Signs and Symptoms.—Irregular growth. The tumour is fixed, and does not move up and down on swallowing. The neighbouring lymphatic glands are enlarged. Pressure symptoms on the trachea and bloodvessels are usually marked. The patient is not able to lie down or sleep. Phonation may be interfered with from pressure on the recurrent laryngeal nerves.

Treatment.—If seen early, the growth may be completely removed; otherwise symptoms are to be treated, and tracheotomy performed to relieve respiration.

Exophthalmic Goitre (Graves' Disease).—The causative factor is not known, but it is thought to be a general poisoning from oversecretion and absorption of thyroid secretion.

Symptoms.—Uniform slight enlargement of the thyroid gland, prominence of the eyeballs, and delay in the descent of the upper lid when shutting the eyes (Von Graefe's sign); tachycardia, palpitation; symptoms referable to the nervous system, tremor and excitability, and even acute mania; sweating; dyspnœa; diarrhœa; glycosuria; local fatty swellings, especially on the abdomen; pigmentation.

In some cases there is no goitre, in others no exophthalmos, while the general symptoms are marked. Cases are frequently seen which are not typical. The best guides in such cases are the vasomotor disturbances and general nervousness.

The protrusion of the eyeballs is due to an accumulation of fat in the orbits, and spasm of the unstriped muscle at the back of the eyeballs. The dyspnœa is due to cardio-vascular changes.

Treatment—*Medical.*—Bromides, belladonna, and digitalis relieve symptoms. Moebius' serum, obtained from animals in which the thyroid gland has been removed, has been found of some service.

Gibson of Edinburgh spoke highly of suprarenal extract. Rest, mental and physical, is of great service.

Treatment by means of X rays is often beneficial.

Operative.—The superior and one inferior thyroid artery on the opposite side have been ligatured with some advantage. The removal of one lobe with the isthmus should be carried out when other treatment is of no avail. The results of the operation are as a rule good, relieving symptoms if it does not cure the condition, which, however, it does in the majority of the cases.

THE TRACHEA.

The trachea may be **lacerated,** torn from the larynx, or have its rings fractured by a direct blow, or as the result of throttling or the passage of a wheel over the neck.

The **Symptoms** of the accident are swelling and discoloration, and, when the mucous membrane is torn, escape of air into the tissues, giving rise to emphysema. Œdema of the glottis may supervene, giving rise to difficulty of breathing, which may end in suffocation. Blood may pass into the lungs and be coughed up, or septic pneumonia may result.

Wounds of the trachea are usually met with as the result of attempted suicide—cut-throat—but are also occasionally seen as the result of a stab or gunshot wound.

Foreign Bodies in the Trachea.—Those most commonly found are tooth-plates and coins. If the foreign body remains movable, it may become displaced on movement or coughing. It may then be drawn upwards to become impacted in the glottis, giving rise to violent paroxysms of coughing and spasmodic dyspnœa. The body, however, especially if a round one, having once passed through the larynx, usually drops into one of the bronchi, the right most often, since it is larger and more vertical than the left. Here it may act as a valve, allowing air to pass out, but none to pass in, thus leading to collapse of that part of the lung. The result may be that the object is coughed up to lodge in the larynx, and may eventually be got rid of altogether, or bronchitis or septic pneumonia may result.

The illustration of the tooth in the bronchus is a unique one. Around the tooth there developed a suppurative broncho-pneumonia; the lung was collapsed, and empyema was present.

Treatment.—Direct examination of the trachea and upper bronchi may be carried out by means of Killian's metal tubes passed through the mouth and larynx or through a tracheotomy wound. Foreign bodies may be located and removed by this means; they may also be detected by means of the X rays.

Tracheotomy.—For the relief of obstruction to breathing arising from any cause, traumatic or otherwise, and for the removal of foreign bodies, etc., the operation of opening the trachea may frequently be called for. The trachea may be opened above the isthmus of the thyroid—**high operation**—or below it—**low operation.** The former is

PLATE LIII.

TOOTH IMPACTED IN BRONCHUS.

(Museum, Queen's University of Belfast.)

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MEMBRANOUS CAST OF THE ŒSOPHAGUS THE RESULT OF AN ACID BURN.

(Museum, Queen's University of Belfast.)

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most easily performed, and there is less risk of bleeding into the lungs, and sepsis. The low operation is to be chosen, however, for relief of cancer of the larynx and for removal of foreign bodies from the bronchi.

Stenosis of the Trachea is met with as a result of pressure from an enlarged thymus gland. It gives rise to progressive dyspnœa, stridor, with paroxysmal exacerbations, during one of which the child may die. The gland should be drawn forwards, and if symptoms are not relieved it should be removed.

Scabbard Trachea is the term applied to the compressed trachea produced by the pressure arising from bilateral parenchymatous goitre. The cartilages become softened, and the trachea may become collapsed if the pressure is not relieved.

THE ŒSOPHAGUS.

Injuries—Wounds.—The œsophagus is rarely wounded from without, except as part of a larger injury in cut-throat and gunshot wounds, etc. It is from within that it is more usually wounded, by swallowing some sharp foreign body or owing to the careless passing of an œsophageal bougie or stomach-tube. The wound may be a mere scratch of the mucous membrane, or it may be so severe as to cause perforation. The milder injuries are attended with pain on swallowing, and a sensation as of a foreign body in the œsophagus. When more severe, there is bleeding, with attacks of coughing and spitting of mucus tinged with blood. If perforation has taken place, cellulitis of the neck and posterior mediastinum may occur.

Treatment consists in giving functional rest to the œsophagus by feeding *per rectum*.

Rupture may take place during violent vomiting or lavage. The rupture is usually near the lower end, and its line is longitudinal.

Burns by Corrosive Poison.—The common substances causing these burns are carbolic, hydrochloric, nitric, or sulphuric acid and caustic potash. The parts of the tube most seriously affected are the upper and lower ends.

The burn may be superficial, or may involve all the coats. The injured tissue necroses, leaving a raw surface difficult to heal.

Sometimes an entire cast of the tube sloughs off, as in the accompanying illustration, which shows unusually well the result of the effects of hydrochloric acid which the patient had swallowed. When she left hospital she was able to bear the passage of a bougie, and to swallow fluids with comfort.

There is profound shock, which may cause death rapidly. Failing this, there is great pain, thirst and vomiting. The sequelæ are numerous, including perforation, cellulitis, abscess, and later cicatricial contraction.

Treatment.—Alkalies when an acid has caused the injury, and weak vinegar when alkalies have been swallowed. When carbolic acid has been taken, a large quantity of olive oil should be given. Feeding should be carried out by the rectum. Bougies should be passed after three weeks to prevent stricture.

Impaction of Foreign Bodies.—If a large body, such as a bolus of unmasticated food or a tooth-plate, slips back, it usually lodges in the pharynx, blocking the entrance both of the larynx and the œsophagus, and may cause instant death. When, however, the object is smaller, as a coin, bone, or pin, it usually enters the œsophagus, and becomes impacted at the point where the bronchus crosses the tube, or where the latter passes through the diaphragm, at which points the œsophagus is narrowed. In young people coins are usually caught at about the level of the upper end of the sternum.

There is generally pain, which is increased by swallowing movements, vomiting and cough being engendered. The obstruction may be complete, in which case even saliva will be vomited up after leaving the mouth, or incomplete, in which case fluids will pass, but solids are usually regurgitated. When the mucous membrane has been injured, the patient will complain of pain of a lancinating nature, and this pain will continue after the obstruction has been removed. By means of the œsophagoscope the object may be seen and removed. The X rays will also show the position of certain foreign bodies ; for the rest, the history usually suffices to render the condition plain.

Treatment.—The object, if possible, should be removed by the aid of the œsophagoscope, which is a form of speculum illuminated by an electric lamp, which enables the œsophagus to be examined to the cardiac extremity—that is, when in expert hands. Forceps may be employed to draw up the object when near the top, and bulbous bougies to push it gently down when its consistency and position permit. If the object is irregular or sharp, and situated in the cervical portion of the tube, œsophagotomy is performed by an incision a little to the front of the anterior border of the sterno-mastoid muscle, on the left side. If the foreign body is situated near the lower end of the tube, gastrotomy is performed, and the object removed through the stomach. When situated midway, two methods are possible—to open the œsophagus through the mediastinum; or to perform gastrostomy and feed the patient by the operation route, to allow of the œsophagus becoming relaxed by means of functional rest, and so letting the foreign body pass onwards. The latter is the better treatment.

Ulceration of the tube by pressure of the body may lead to perforation, setting up septic cellulitis, or perforation of the air-passages may lead to septic pneumonia. Occasionally the large vessels are eroded and give way, when fatal hæmorrhage occurs.

Œsophagitis.—Inflammation of the œsophagus may be acute when it is due to pyogenic infection arising as a result of direct trauma by foreign bodies, or to swallowing corrosives. The inflammation may spread to the surrounding tissue, where it is termed **pericœsophagitis.**

A chronic false form is seen in drunkards. There is acute pain, difficulty in swallowing, and regurgitation due to spasm. The condition resembles the presence of a foreign body or stricture.

Stricture—1. **Tuberculous.**—The disease as a rule spreads from the bronchial glands, ulceration occurs, and when healing takes place a cicatricial contraction remains. The condition is evidenced by the existence of tubercle elsewhere. The symptoms in the acute stage of ulceration are pain during and after taking food, dysphagia, and

STENOSIS OF THE LOWER END OF THE ŒSOPHAGUS CAUSED BY SQUAMOUS-CELLED CARCINOMA.

(Museum, Queen's University of Belfast.)

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regurgitation of blood-stained food. The condition at this stage may be mistaken for gastric ulcer or malignant disease.

2. **Syphilitic Stricture,** due to a healing ulcer, is not common. The symptoms are somewhat similar to the tuberculous lesion, but the pain in the acute stage is not so severe, and there is less likely to be bleeding.

3. **Traumatic Stricture** is the most common form. It may be due to healing of a wound, but most usually to the cicatrization which follows the swallowing of caustics. The stenosis may be general, irregular, or confined to bands at the upper and lower ends of the tube. Above the line of stricture there is usually dilatation, and here a diverticulum may form.

There is a gradually increasing difficulty in swallowing. The patient may be able to locate the position of stricture. Later on there is regurgitation of food after a shorter or longer interval, according to the position of the stricture. Pain may be referred to the stomach or to between the shoulders. There is usually marked emaciation from starvation.

Diagnosis.—History confirmed by examination with the œsophagoscope or by use of bougies. A full-sized olivary bougie should be used to start with, and the size gradually reduced till the size and site of the stricture is located, and also the presence of more than one diagnosed.

Treatment.—Spasm may add to the difficulty of passing a bougie. To obviate this, the patient should have rest for a few days and be fed by nutrient enemata.

For ordinary stricture of average tightness, a graduated bougie should be passed every third day till the condition is cured, after which it is well to pass a full-sized bougie once a month.

When the stricture is resilient, continuous dilatation is preferable. This is carried out by means of a Symonds' intubation tube, which is left in for about thirty-eight hours, and larger sizes substituted till the stricture is fully developed. The patient can be fed through the tube or by nutrient enemata. In rare cases the stricture is impassable, and it is necessary to pass instruments from below through a wound in the stomach. A better method is to pass up a silk thread attached to a fine bougie, and use the silk as cutting material to divide the stricture.

4. **Malignant Stricture** is due to the growth of a squamous epithelioma, usually in the lower third of the œsophagus. The occurrence of complete stricture is a late sign of the presence of the disease, which at first usually spreads over a considerable portion of the wall before surrounding it, and frequently involves the neighbouring tissues.

The **Symptoms** at first resemble those of cicatricial stricture. Dysphagia is a marked symptom, which comes on gradually when the whole circumference of the tube is not affected, and which may be intermittent more often than in simple stricture. Hæmorrhage may be a prominent symptom, and vomiting sometimes occurs. The food which is regurgitated is frequently mixed with blood. Emaciation is rapid, and out of proportion to the inability to take food. Death usually occurs in about twelve months from starvation, sepsis, or hæmorrhage.

The disease implicates the **cervical** part of the tube most frequently in females, and forms a swelling which may be felt behind the larynx. It tends to invade early this organ and implicate the recurrent

laryngeal nerve. The special symptoms when in this position are persistent cough, aphonia, or merely hoarseness, and expectoration of large amounts of blood-marked mucus.

Treatment.—Occasionally the disease may be capable of removal when in the cervical portion. In other cases, if the stricture is sufficiently passable, a Symonds' tube may be inserted, and left in position for some time; when impermeable, gastrostomy must be performed, and the patient fed through the tube in the wound.

5. **Spasmodic Stricture** is due to spasm of the muscular coat in neurotic females or drunkards.

There is intermittent dysphagia, which frequently comes on in a very sudden manner, especially if the person is excited.

Treatment.—Bromides should be given and a full-sized bougie passed occasionally.

Malformations — Congenital.—Stricture or diverticula and imperforate œsophagus which are very rare.

Acquired Malformations are of two kinds: general dilatation and diverticula.

Dilatation.—This is frequently associated with paralysis of the muscular coat, an organic stricture, or with cardio-spasm.

Diverticula.—This may form in the œsophagus where the wall is weak, and may be due to pressure from within, usually occurring at the junction of pharynx and œsophagus. The " sac " of the pouch may be formed of all the coats of the tube, or of the inner one only, which is drawn through the outer. The opening is about the level of the cricoid cartilage, and the sac hangs down parallel with the œsophagus. It may vary in length from 1 to 6 inches.

Symptoms.—Dysphagia and regurgitation from pressure on the œsophagus. There is a sense of oppression due to the lodgment of food in the diverticulum, which may cause a swelling in the neck. Diagnosis may be made by the use of the œsophagoscope, or by passing one bougie down the œsophagus and another into the pouch.

Treatment.—Excision of the pouch and suturing the œsophagus is the most reliable method of treatment.

Diverticula are also produced by traction from without. They are usually situated on the anterior aspect of the œsophagus, at the bifurcation of the trachea. They are small and funnel-shaped. Their production is said in many cases to be due to traction by adherent tuberculous bronchial glands. They are productive of no symptoms as a rule, and usually remain undiscovered.

Congenital Malformations and Deformities.—See Chapter XIV.

CHAPTER XXIV

INJURIES AND DISEASES OF THE THORAX

Contusions—Wounds—Hæmothorax—Pneumothorax—Hæmoptysis—Surgical emphysema—Injuries to the lung—Abscess—Diseases of bone—Lipoma—Sarcoma—Empyema — Hydrothorax—Pulmonary abscess — Gangrene — Hydatid cysts—Wounds of the heart—Tapping the pericardium—Mediastinitis—Injuries to the diaphragm—Diaphragmatic pleurisy.

INJURIES OF THE THORAX.

Injuries to the thorax may be divided into—(1) those confined to the soft tissues, (2) those in which ribs or sternum are engaged, (3) those which are complicated by injury to lungs or heart. This classification is, however, artificial, as one injury may partake of the characteristics of all three divisions.

Contusions of the thorax may be caused by a fall or crush, by a blow, or by being run over by a vehicle. This last is one of the most frequent causes. The contusion may be slight, followed by complete recovery in a few days, or may be severe with considerable shock, followed by dyspnœa, palpitation of the heart, affections of pleura, lungs, and pericardium. A severe blow on the thorax may prove fatal without any evidence of external injury.

Contusion of the ribs gives rise to similar symptoms to those of fracture. It is often impossible to differentiate between the two, but a radiograph will enable the surgeon to arrive at a definite conclusion. In these cases no permanent injury is likely to result.

Rupture of the pectoral muscles is sometimes seen, but it is rare.

The heart may be injured by concussion, or the cardiac muscles and valves by crushing or strains. Some years ago a man was on exhibition in Belfast who was styled the "Blue Man," from his markedly cyanosed appearance. He was in a Lancer regiment, and while exercising his horse fell on him, the resultant injury opening up a communication between the right and left sides of the heart—the condition found in the fœtus. He lived about eight years after the accident.

If the heart is already the seat of organic disease, it is much more likely that serious effects will result from injury than when the organ is normal. Aneurism of the thoracic aorta has been known to follow injuries.

The condition of the heart following accidents is a common cause of dispute in the law-courts, and there is little doubt that cardiac disease may be started by injury.

Treatment consists in combating shock, which may be considerable, attending to bruised tissue in the ordinary way, and keeping the patient in bed for a few days.

Wounds.—Unless they are penetrating and injure some internal organ, these call for no special mention, except to note that they are attended at times with subcutaneous emphysema caused by air being drawn into the wound by the respiratory movements. Treatment is on general lines.

Fractures of ribs and sternum have been already considered under Fractures (Chapter XII.).

Injuries to Viscera.—These may be caused by **penetrating wounds,** contusions, etc., or may occur independently of injury to the chest walls.

Hæmothorax (effusion of blood into the pleural cavity), may be due to a wound of the pleura, lung, or heart, occasionally of the diaphragm or of a bloodvessel.

Symptoms. — Signs of fluid in the pleura. Shock from internal hæmorrhage. The patient is restless, with embarrassed respiration and small, weak pulse. Sometimes the symptoms do not develop for some hours after the accident owing to initial shock, and they may come on suddenly at the period of reaction. Serous fluid may be poured into the pleural cavity some days after an accident, when an exploring needle will be required to clear up the diagnosis. The fluid blood is usually reabsorbed.

If the wound be a penetrating one, blood will come to the surface on coughing or movement.

Pneumothorax (escape of air into the pleural cavity) may result from a laceration of lung tissue in fracture of a rib or by the penetration of a foreign body, or unusual strain.

Signs and Symptoms.—Bulging of intercostal spaces, hyper-resonance, loss of vocal fremitus, faintness of vocal resonance and breath sounds. The patient is restless, breathing is embarrassed, and cyanosis may be present. When serious collapse of the lung takes place, the heart, liver, and spleen, may be displaced. Under normal conditions, and when septic organisms do not gain admission, the wound in the lung heals, the air is absorbed, and the symptoms clear up in a few days. Should blood and air together gain ingress to the pleural cavity, the condition is known as **hæmo-pneumothorax.**

Hæmoptysis (spitting of blood) apart from disease follows both contusion and a wound of the lung—usually the latter, when the blood appears at once, is copious in amount, bright red, and frothy.

Surgical Emphysema (escape of air into the subcutaneous tissue as the result of injury) usually follows small valvular punctured wounds caused by a broken rib or a pointed weapon. The air may pass into the neck when the pleura is not torn, and the lung is, or in other cases air may spread widely under the skin when lung and pleura are torn.

Injuries to the Lung.—As a rule these are associated with fracture of the ribs or a penetrating wound. Hæmorrhage takes place by the mouth and through the wound if there be one, and blood and air find their way into the pleural cavity.

There is considerable shock, and death may result from the hæmorrhage.

Treatment.—Rest in bed in a semi-lying position, and shock combated, avoiding, however, active stimulation, owing to the risk of increasing the hæmorrhage.

If hæmothorax be present, and the blood is causing pressure symptoms, a **portion** of it should be aspirated slowly. Venesection is sometimes useful to relieve pressure on the heart. If septic changes

take place, free drainage must be established by resection of one or more ribs and incising the pleura.

Pneumothorax may require removal of air through a hollow needle to relieve dyspnœa.

Hæmoptysis is treated by injection of ergotin and giving the patient ice to suck.

When a penetrating wound injures an **intercostal artery,** a double piece of gauze should be pushed between the ribs and tightly packed between the layers with pads. If this fail, the vessel must be exposed and tied. In order to do this, it may be necessary to resect the whole or portion of a rib. When the **internal mammary artery** is wounded, it should be exposed and tied in the second intercostal space.

When the lung is **prolapsed** through a wound or **herniated** through a weak parietal wall, it should be replaced, if possible, and the opening closed. If this is not possible, the lung should be protected from pressure. Should a protruded portion become gangrenous, it must be removed after ligaturing the sound portion to prevent hæmorrhage.

Rupture or division of the **thoracic duct** is a rare accident, nor are the results so very serious, as was formerly supposed, provided the vessel can be secured. This is owing to the fact that in many cases the duct opens by several mouths into the subclavian vein. If, however, there be but one mouth or the vessel is not secured, the case will end fatally. Even when the flow of chylous fluid has continued for some time, the vessel being subsequently ligatured, profound exhaustion, which may end fatally, occurs. If this be averted, the condition will take some time to recover from the effects.

Theim reports a case of rupture of the duct in which there was a large swelling above Poupart's ligament.

DISEASES OF THE THORAX.

As the result of infection spreading from the axillary glands, **Cellulitis** of the subcutaneous tissue occurs. It is evidenced by a hard swelling, which may extend over half the chest. The skin is reddened, and there is some tenderness. Respiration is impeded on account of the pain. Pus forms in a few days, when fluctuation may be detected. The pus usually bursts on to the chest, rarely into the pleural cavity.

Treatment consists in making multiple incisions, and stimulation of the puncture must be carried out energetically.

An **Abscess** is occasionally met with as the result of a foreign body being lodged in the chest wall and following infective processes in the bones of the chest, or from spread of suppuration from inside the chest walls.

Treatment.—As elsewhere.

Tuberculous Disease of Bones.—The ribs and sternum may be affected about middle life with this disease, which may be primary or secondary to disease of **spine** or **pleura.**

Treatment.—Remove the abscess, its contents and the affected part of rib in one piece if possible.

Syphilitic Disease.—Principally met with in the sternum as gummata, breaking through the skin they form typical ulcers.

Treatment.—Constitutional for syphilis, with local removal of the diseased portion of bone.

Tumours in this situation are usually—

Lipoma.—Met with chiefly on the back. It should be removed when causing inconvenience.

Sarcoma and Chondro-Sarcoma.—The former in the sternum, the latter in the ribs near their junction with the cartilages are met with. These tumours are painless and give rise to few symptoms. They may attain to great size, and should be removed as early as possible, before the visceral pleura is affected.

Malignant diseases of the chest may be secondary to that in the breast.

Empyema.—The only condition of pleural effusion with which the surgeon is concerned is that in which it is converted into a purulent or sero-purulent fluid by means of infection with pyogenic or tuberculous organisms.

1. **Pyogenic Empyema.**—Most commonly the condition follows pleurisy or pneumonia; less frequently it is caused by infection through a penetrating wound, or from the bursting of liver and subphrenic abscesses through the diaphragm, or carried by the blood-stream in acute infective diseases, such as typhoid fever and influenza.

The organisms concerned are pneumococci, streptococci, and staphylococci. The condition caused by the pneumococcus is the least serious. The effusion usually remains thin except when the condition is of long duration, when lymph forms in large masses and becomes adherent to the surface of the pleura. This form frequently follows pleuro-pneumonia in children.

The streptococcal infection is that usually present in adults, and frequently follows influenza and scarlet fever. The pus is thick, and often contains flaky masses, while the pleura frequently becomes thickened and forms adhesions, thus dividing the cavity into separate loculi.

Symptoms.—Empyema may be suspected in certain cases of pleurisy when the patient does not progress and the case seems to do badly; but often it is very difficult to arrive at a definite conclusion about a case until an exploring needle is used. The difficulty arises largely from the fact that the symptoms are masked by those of the pre-existing condition. There are, however, certain cases, usually those caused by the bursting of an adjacent abscess, where there is a sudden increase in the severity of symptoms, which includes a gravely embarrassed respiration. These give the suggestion of emphysema.

Certain **general symptoms** are met with in all cases. Such are—flattening of the side of the chest with bulging of intercostal spaces (not always present), dulness on percussion, absence of breath sounds and of vocal fremitus on auscultation. There is also a certain amount of immobility of the affected side. The temperature is raised, and there may be rigors, and dyspnœa is a pretty constant symptom. There may be displacement of heart, liver, or spleen. It must, however, be remembered that many or all of these symptoms may

be present in an ordinary pleurisy, and, as pointed out above, it is often necessary to use an aspirating needle to clear up the diagnosis. If empyema be present, the fluid will be found purulent or turbid, with a large amount of cellular elements present.

Treatment—Aspiration.—This is useful in children suffering from the pneumococcal form of the disease, and in those who are very weak, but as a routine treatment it cannot be relied upon.

Incision and Resection of Rib.—This is best carried out over the seventh, eighth, or ninth rib, the incision being made in the mid or posterior axillary line in the long axis of the rib, and a portion about 1 to 2 inches in length removed. This treatment provides for drainage, and enables the surgeon to break down septa and to remove the masses of lymph that in many cases are adherent to the pleura.

A couple of large-sized drainage-tubes are inserted, so as to project one-third of an inch within the pleural cavity, the other ends being kept in place by means of a shield or safety-pin. The tubes should be removed for cleansing alternately, once or twice a day, according to the discharge, and retained so long as it is purulent. The patient should lie on the affected side to promote discharge, the end of the tubes being covered with a piece of oilsilk. The patient must be encouraged to breathe deeply in order to promote expansion of the lung.

The operation requires general anæsthesia. This, though not free from risk, owing to embarrassed respiration and heart action, can be carried out if great care be taken. The patient should be put under by a mixture of chloroform (2 parts) and ether (1 part), and kept under with chloroform alone. The patient should be put under in the ordinary position, and, when ready, turned gently on to the sound side, but only kept there for as short a time as possible. Some recommend that the patient should be kept on his back, with the affected side projecting over the side of the table. In some cases, when the embarrassment of the heart is pronounced, the operation may be carried out under local anæsthesia.

2. **Tuberculous Empyema.**—This may be secondary to pleurisy of tuberculous origin or to the bursting of a tuberculous cavity from the lung. In the latter case the onset will be sudden, and there will be considerable constitutional disturbance ; but in other cases the onset is indefinite and the progression slow.

The **Treatment** is not satisfactory, as the lung fails to expand owing to the long-continued pressure and fibrous changes. Moreover, the sinus usually continues to discharge, and may eventually become septic, leading to hectic fever and a chronic empyema. Constitutional treatment should be persevered with, since to it a cure may sometimes be attributed.

3. **Chronic Empyema.**—This may follow tuberculous or pyogenic empyema when the cavity does not close completely by the expansion of the lung and the approximation of the ribs. The pleura which lines the post-empyemic space is thickened and covered with granulation tissue; one or more sinuses usually persist, leading from this cavity to the surface, through which pus escapes, sometimes continuously, sometimes intermittently. As a result the patient usually succumbs from septic poisoning, hectic fever, or waxy disease.

Treatment.—With a view to closing the cavity, the Estlander-Schede operation is carried out. This consists in excising portions

of several ribs, the number and amount removed depending on the size of the cavity, and so allowing the parietes to fall in. It is sometimes necessary to perform **decortication** of the lung, when it is bound down posteriorly by the thickened pleura. This consists in freeing the lung from the pleura and stitching it to the skin flap.

Hydrothorax.—In certain diseases, as advanced kidney and heart trouble, the circulation is so poor that a passive effusion takes place into the pleural cavity. The condition is usually bilateral and unattended with pain or fever. When air is also present, the condition is known as **hydro-pneumothorax.** If embarrassment of respiration or cardiac action is threatened by the pressure, the fluid must be drawn off.

Pulmonary Abscess.—This is usually the result of septic pneumonia, but may be due to empyema or liver abscess combined with gangrene of the lung.

There is a plentiful yellow sputum which contains fibres of elastic tissue and hæmatoidin crystals. If the abscess ruptures into a bronchus, there is expectoration of a quantity of foul pus. There are usually the physical signs of a cavity in the lung, which may be located by means of the X rays.

Treatment.—Pus should first be sought for by means of an aspirating needle, and then, with the needle in position, a free opening is made in the chest wall, with resection of two or more ribs.

Gangrene.—Gangrene of the lung usually results from septic pneumonia, wounds, embolism, or pulmonary apoplexy. There is a copious putrid expectoration, accompanied by an exceedingly foul odour of the breath, and sometimes severe hæmorrhage. The affected area is commonly near the base, and the pleural cavity is protected by adhesions. Treatment is much the same as for abscess.

Hydatid Cysts of the lung, when existing, are usually incised and drained.

THE HEART.

Wounds.—These may be non-penetrating, and are usually inflicted by stabs or a broken rib, while penetrating ones may be caused by stabs or by gunshot injuries, the bullet either passing through the heart or remaining in its cavity. Needles have also been known to pass into the heart from the chest wall or from the œsophagus; they do not as a rule produce any grave symptoms.

Symptoms.—Penetrating wounds are usually rapidly fatal from hæmorrhage, either internally or into the pericardium. The patient is collapsed, has extreme pallor, and is very restless. Dyspnœa is a marked symptom, and the action of the heart is loud, irregular, and feeble.

Treatment.—If bleeding can be arrested, the clot may become organized; but death even then has frequently taken place some days later, owing to softening and movement of the clot from sepsis, or exertion on the part of the patient.

The chest wall having been opened, the heart should be sutured with fine silk or catgut, and the pericardium sewn over it after being emptied of clots.

Cardiac Massage for chloroform-poisoning is carried out through the diaphragm, an incision being made in the epigastric region.

Tapping the Pericardium.—This is done to relieve pressure from effusion. A fine needle is passed through the fifth left intercostal space about 1½ inches from the sternum. The fluid should be withdrawn gradually.

When the effusion is purulent, an incision should be made and drainage established.

When the **pericardium** is **adherent,** usually as a result of inflammation of the mediastinum, a strain is thrown on the heart which leads to hypertrophy. **Cardiolysis** should be performed to relieve the condition. This consists in removal of a portion of several ribs over the heart and freeing the adhesions, which allows the enlarged heart more room to work in.

MEDIASTINUM.

Mediastinitis.—Inflammation is usually met with in the **anterior mediastinum** owing to extension of deep cellulitis of the neck or infective conditions of the air-passages or gullet, etc.

Symptoms.—Pain behind the shoulders; the skin on the front of the chest becomes red and œdematous; and if an abscess forms, pain may be elicited by pressure on the sternum. A rigor may occur which is followed by sweating; the heart may be irregular and the breathing shallow and quick, while a feeling of oppression is common. If the abscess makes its way to the surface, it will probably point in one of the intercostal spaces; if it does not, it will burst into the trachea, œsophagus, pleura, or pericardium. As already pointed out, an after-result may be the formation of adhesions with the pericardium, interfering with the action of the heart.

Treatment.—The mediastinum should be opened by means of a trephine placed over the sternum, or by incising the tissues at the side, and resecting the desired amount of bone to allow of drainage.

Sometimes an abscess may form in the **posterior mediastinum.** It is usually secondary to disease of the spinal column or the œsophagus. If the abscess comes to the surface, as it sometimes does, above the clavicle, it is opened in that position; otherwise it is necessary to divide a transverse vertebral process, and remove it together with a portion of a rib.

Tumours are sometimes met with in the mediastinum. They are usually formed by tuberculous or malignant disease of the bronchial glands, or by an aneurism of the thoracic aorta. Pressure may be exerted by them on the air-passages, œsophagus, or the recurrent largyneal nerve.

THE DIAPHRAGM.

Wounds are not common except as part of a much larger injury involving the abdominal or thoracic contents.

Rupture may occur from a great increase of intra-abdominal pressure suddenly exerted. The condition is evidenced by shock, hæmorrhage, and local pain, which is increased by coughing and deep breathing. A peculiar grinning expression, ordinarily produced by spasm of the muscles about the mouth—the **risus sardonicus**—is often present. It is supposed to have some relationship to pathological conditions

of the diaphragm. The abdominal viscera may be displaced, even into the thorax.

Treatment.—Owing to the constant movement of the diaphragm healing is very difficult, and the rupture may remain open or heal weakly, and form a site for a future **diaphragmatic hernia.** Any lesion of the viscera should first be attended to, and the tear may then be sutured. In many cases it is not advisable to try to do so.

Diaphragmatic Pleurisy.—Inflammation of the pleura in contact with the diaphragm may resemble in its symptoms acute appendicitis or ruptured gastric ulcer.

Septic Conditions may spread through the diaphragm from the thorax to the abdomen, or *vice versa.*

CHAPTER XXV

AFFECTIONS OF THE BREAST

Malformations—Affections of the nipple—Engorgement—Mastitis—Chronic abscess—Mastodynia—Cysts—Tumours.

MALFORMATIONS.

Amazia.—This is a condition in which there is an absence of both breasts; more usually there is only absence of one. Associated with this condition there is often imperfect development of the pectoralis major muscle and part of the chest wall underlying it.

Athelia.—A congenital absence of the nipple, usually bilateral.

Micromazia. — A condition in which the breast remains undeveloped. It is usually associated with imperfect development of the genital organs and of the chest wall.

Polymazia.—Abnormal number of breasts.

Polythelia.—Abnormal number of nipples.

These conditions are not common. The accessory structures may be, and usually are, situated on the chest wall, but are present in other situations, as the abdominal wall, axilla, or the limbs. They have no function as a rule, and their removal may be necessary if they give rise to pain or discomfort.

Hypertrophy.—The enlargement is due to increased development of the fibrous and fatty parts of the organ, and to a less extent of the gland tissue itself. It is usually bilateral, and appears at puberty or in the early months of pregnancy. The breasts are firm and elastic to palpation; the nipples are not affected. There is little pain. The only symptom of moment is the inconvenience caused by the size and weight of the organ, which may necessitate removal. One breast should be removed at a time, as it may happen that the other diminishes.

Gynecomazia.—An enlargement of the male mamma which may be unilateral or bilateral. The stroma of the gland is affected. The condition may be associated with some malformation of the genital organs. It needs no treatment unless the size of the breast becomes excessive, when it may be removed.

AFFECTIONS OF THE NIPPLE.

The nipples may be small and depressed either congenitally or as a sequel of cicatricial contraction—conditions of little importance unless in the nursing mother, when the efforts of the child to hold and to retain the nipple may cause cracks or fissures. The condition

may be usually relieved by traction on the nipple or the use of the breast-pump.

Cracks and Fissures caused as above, and in certain cases by lactation. They owe their importance to the fear of sepsis leading to a formation of an abscess. They may be prevented as a rule by proper care during the latter months of pregnancy. The corset should not press on the nipple, which, if retracted, should be drawn forwards with the fingers. The breast-pump is seldom needed. The nipples should be bathed with some mild antiseptic lotion, and hardened by applying methylated spirit. Eau-de-Cologne, frequently recommended for this purpose, is of little use. During lactation, the nipple after nursing should be bathed with boric lotion, dried and dusted with emol keleet or some other simple powder. An artificial nipple should be used during nursing, if the cracks are painful. The child's mouth should be carefully disinfected to avoid infection of the breast.

Eczema.—This may be acute, chronic, or the first stage of **Paget's disease,** in which the nipple becomes destroyed and the surrounding tissue indurated. The disease is believed to be a carcinoma starting in the deep layers of the epidermis, and then invading the skin and milk-ducts, and finally spreading to the underlying portion of the breast.

Treatment.—When the eczema is simple, it will clear up under ordinary treatment. If it does not do so, the nipple should be excised and a section examined under the microscope. If malignant disease be found to be present, the breast and its glands should be removed.

Syphilitic Affections.—Primary chancre is occasionally met with on the nipple of a healthy woman who has acted as a wet-nurse to a syphilitic infant ; but the mother of the child is not affected. The axillary glands are enlarged and hard. Secondary mucous patches are met with.

Tertiary affections, as gummata and ulcers, are rare.

Treatment.—Antisyphilitic.

Malignant Disease.—Epithelioma sometimes occurs as a deep ulcer, causing destruction of the nipple and surrounding skin. The breast and glands should be removed.

Carcinoma, except as Paget's disease, and **Sarcoma** are rare.

AFFECTIONS OF THE BREAST.

Engorgement of the breast occurs as a physiological process during pregnancy and lactation. If for any reason the milk is retained, milk fever develops. The breast then becomes very tender and congested. The milk should be drawn off, and the further secretion prevented by administering bromides, belladonna, and salines.

Pathological Engorgement may occur in infancy (mastitis neonatorum), at puberty (mastitis adolescentium), or during some acute infective disease, particularly mumps.

Inflammatory Disease—Acute Mastitis.—This condition is set up by pyogenic infection, most usually occurring during lactation, the engorged condition of the gland at that time being favourable to the development of organisms. They enter by means of a crack, and are derived from the surrounding skin or the mouth of the infant, and gain access to the breast by the milk-ducts or though the lymphatics.

The organism usually responsible is the staphylococcus. Acute mastitis may also be part of a general pyæmic condition. It may be secondary to infective parotitis, or be an extension of disease from neighbouring structures, as the ribs or pleura. The abscess may be supramammary ; intramammary ; or retromammary—*i.e.*, situated between the ribs and the breast.

Supra- or **Premammary Abscess** may begin either as a superficial cellulitis or a suppurative inflammation of a sebaceous gland. The abscess in this situation gives rise to few constitutional symptoms, and a simple incision leads to rapid cure.

Intramammary Abscess is that most frequently met with. The pus is found in the breast substance. At first it is limited to one or more lobules, by radiating fibrous septa, later the whole organ may be involved and form a multilocular abscess. The retention of milk in addition to the inflammatory process causes the whole breast to become enlarged.

Signs and Symptoms.—Local pain and heat with raised temperature. At first a diffuse redness is seen over the organ, and a deep-seated swelling, uniformly tense, may be felt. When suppuration occurs, the redness becomes of a more dusky shade, and the swelling above the pus becomes prominent and softer, ending in fluctuation. The pus finds its way to the surface, and, if the abscess is not observed, will burst, usually close to the areola.

Treatment.—In the early stages the treatment should aim at prevention of suppuration by relieving the milk engorgement and inducing active hyperæmia by means of a Klapp's suction bell, applied over the site of the inflammation for about one hour twice daily. Multiple radiating superficial incisions may be made, to allow of the discharge of inflammatory exudation.

If pus has formed, and is burrowing in the substance of the organ, free, radiating incisions should be made, and all septa broken down, so that no pockets containing pus remain behind. A counter-opening in the lower segment of the breast may be required for drainage.

Sub- or Retromammary Abscess.—Here the pus is between the breast and the chest wall. It may arise from disease of the ribs or the bursting of an empyema through the chest wall, or may be an extension of the last-named form of abscess.

The breast is pushed forward, but is not inflamed, and fluctuation may be detected at the circumference or, in a small, flabby organ, on deep palpation from the front.

The abscess should be opened at the lower and outer part of the breast, where it usually points if untreated.

Chronic Mastitis (Multiple Cystic Disease).—In the **lobar** form it usually results from a former acute mastitis, from injury, or from imperfect involution after lactation.

There is pain of a neuralgic type, which is increased during menstruation.

Cancer may be suspected, but there is no enlargement of glands as a rule. The flat hand detects no tumour, and no hard edge can be felt.

Treatment.—Belladonna and glycerine should be applied, and the breast placed at rest by means of a firm bandage.

Lobular or Interstitial Mastitis.—This occurs in women about the menopause, and frequently in those who have borne no children.

There is an overgrowth of the interstitial fibrous tissue, with contraction and consequent pressure on the ducts; proliferation of the epithelium takes place, and dilated acini may form cysts which become filled with a thick, mucoid substance.

Signs and Symptoms.—The whole breast feels nodular; pain is not a marked symptom, but is worse during menstruation. The glands are often enlarged, and the nipple retracted from being dragged upon by the fibrous tissue. The hand laid flat, however, detects no hard tumour when pressed against the chest wall. One or more soft tumours may be seen and felt. Where cysts form, these are elastic in character. The organ may atrophy and **polycystic disease** develop, while carcinoma sometimes follows the condition. There are no intracystic growths when the condition is entirely innocent.

Diagnosis.—The disease has to be distinguished from commencing carcinoma and from fibro-adenoma.

Treatment.—At first a belladonna plaster, mercurial ointment, or liniment of potassium iodide may prove beneficial, and relieve pain if present; while iodides internally are advisable, especially if a syphilitic taint be suspected.

If these methods fail, an exploratory incision should be made. If found to be innocent and the disease is limited, the affected portion may be removed; but if there are any signs of malignancy, as intracystic growth, the entire organ and the glands should be removed.

Chronic Abscess of the Breast.—This may be due to **tubercle, actinomycosis,** or **sepsis.** The former two closely resemble one another in their clinical phenomena; the only point that distinguishes them is the presence of the tubercle bacillus in the one, and the ray fungus in the other. Their onset is slow and unattended with pain, so that the disease is often well established before it is detected. The breast is swollen and nodular, but later several soft parts may be detected. These coalesce, and an abscess is formed in the substance of the breast. The pus travels towards the surface, and, if unrelieved, breaks through the skin. The axillary glands are usually enlarged.

Treatment.—When the tuberculous process is limited, a partial excision may be carried out. When diffuse, the whole organ and its glands, if markedly enlarged, should be removed. In actinomycosis large doses of potassium should be given in the early stage. Later, if the disease is localised, partial excision may be carried out; if not, complete excision of the affected breast is the best treatment when the disease is primary. Both tubercle and actinomycosis are rare in the breast.

The septic form of chronic breast abscess may be due to infection of a hæmatoma following injury and infection of a retention cyst, or be part of an acute suppuration which has been left behind. It forms a badly-defined swelling in the breast substance. The fluctuation may be difficult to obtain on account of the walls of the abscess being as a rule thick. There may be pain of a throbbing kind, and tenderness on making pressure over the site of the abscess. A discharge of a purulent character may be expressed from the nipple, which is retracted. The glands of the axilla are enlarged and tender. The condition requires to be diagnosed from a new growth or a cyst.

Treatment.—The abscess should be dissected out. If this be impossible, it is opened and drained.

Mastodynia (Neuralgia).—Occurs in young females of a neurotic temperament, and is associated with genital disturbances. The pain is increased during menstruation, and is of a severe shooting character, the breast being very sensitive to touch.

Treatment.—Tonics should be administered, and any coexistent trouble treated. Locally a belladonna plaster should be applied, and the breast supported by a bandage. It is well to reassure the patient that the trouble is not of a grave character.

CYSTS.

Retention Cysts.—These are formed by the dilatation of acini. There is frequently a serous discharge from the nipple. **Galactocele** is a retentive cyst formed by the dilatation of one of the main lacteal ducts, which is occluded by cicatricial contraction in or around its walls. The cyst is filled with altered milk. It usually occurs during lactation, and when it ceases the tumour may disappear, but may re-form when active function is renewed. If the cyst does not disappear when lactation is over, it should be excised. The condition is usually painless, and there is no retraction of the nipple or enlargement of glands.

Involution.—These **Cysts** occur in the course of interstitial mastitis about the menopause or during the normal process of involution; a blocking of the ducts takes place owing to contraction of the fibrous tissue, which leads to distension. These are also called **Distension Cysts,** in which category may be included what is sometimes called an **Irritative Cyst,** said to be due to irritation of the nipple causing a reflex secretion. The **Serous Cyst,** said to be due to a dilatation of a lymph space, is really in most cases an involution cyst.

If involution cysts are multiple, the breast should be removed; if single, it may be dissected out.

Hydatid Cysts are very rare in the breast.

Cystic degeneration may occur in any new growth of the breast.

To sum up, the primary cysts of the breast usually met with are—

(*a*) Galactocele during lactation.
(*b*) Involution cysts at the menopause.

BREAST TUMOURS.

These may be simple or malignant.

1. Simple.—Of the former, lipoma, chondroma, osteoma, and angioma, while occurring sometimes, are so rare that it is not necessary to refer to them in detail. Those which are comparatively common are adenoma and duct papilloma.

Adenoma.—These tumours consist of tissue which resembles the normal tissue of the breast. They have a firm fibrous capsule enclosing epithelial alveoli with branching tubes, and acinous spaces, which are often dilated and form cysts which may contain intracystic bodies and a variable amount of fibrous tissue. The tumours are

divided into **soft** and **hard,** according to the amount of fibrous tissue present, or they are also termed—

(*a*) **Pure Adenoma (Acinous Adenoma)**, which consists of tissue similar to the gland and having little fibrous tissue.

(*b*) **Fibro-Adenoma (Tubular Adenoma).**—This is much the most common variety. In it the fibrous element is much more prominent than the glandular ; the alveoli are drawn out into long, very narrow canals, and the fibrous tissue grows into them.

(*c*) **Cystic Adenoma.**—In these the alveoli are dilated, and form cysts which are filled with fibro-papillomatous proliferations. They usually attain large size, and may burst through the skin. Sarcomatous changes may occur in them.

Signs and Symptoms.—The hard form of fibro-adenoma usually occurs in young unmarried women. There is frequently the history of an injury. The pain is neuralgic in character, usually worse during menstruation. The tumour presents a rounded or oval swelling, usually smooth and elastic, but occasionally nodular. It is freely movable in the breast substance, and not fixed to the overlying skin, to the nipple, or to the chest wall ; nor is there any enlargement of the axillary glands or retraction of the nipple. On section the growth is found to be hard, of a white colour, foliated, and no juice can be scraped from it.

The soft or glandular form differs from the above in being less hard and usually attaining a larger size.

The cystic form as a rule occurs in older women and is considerably larger, giving to the breast a lobulated appearance. They grow more rapidly, and in parts of the tumour fluctuation may be elicited ; the skin is often of a bluish colour and traversed by dilated veins. A symptom characteristic of the condition is a serous or sero-sanious discharge from the nipple.

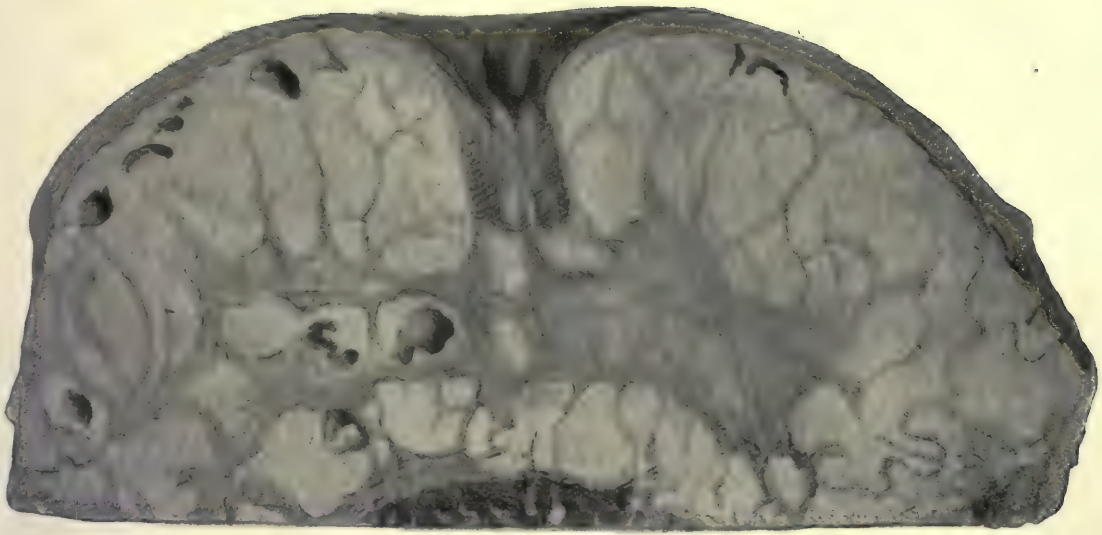
Treatment.—All forms of adenoma are best treated by removal. In the case of the hard and soft forms, the tumour can be excised from the breast either by an anterior incision radiating from the nipple, or if of large size, or necessitating the removal of part of the breast substance, an incision may be made at the outer and lower part of the organ, which is then turned up from the pectoral fascia and the tumour removed from the posterior aspect. The cystic variety entails the removal of the whole breast, since malignant disease is liable to occur.

Duct Papilloma.—This occurs as a small tumour near the surface and in the vicinity of the nipple. A small papilloma having a pedicle grows from the wall of one of the large ducts. There is a clear or slightly blood-stained discharge from the nipple, which may be present some time before the growth is detected. There is no induration or enlargement of glands.

Treatment.—The tumour should be removed together with a thin layer of breast tissue, which is carefully examined for signs of malignancy.

If the epithelium of the papilloma grows down through the wall of the duct, the tumour becomes indurated at the base, and the glands of the axilla become enlarged, indicating the formation of a **Duct Carcinoma,** which is a slow growth of feeble malignancy. For this condition the whole breast and glands should be removed.

PLATE LVI.



H.R.D.

SCIRRHOUS CARCINOMA OF BREAST.

Note the radiating bands from the growth and the retracted nipple.

(Museum, Queen's University of Belfast.)

[To face page 501.

2. **Malignant Tumours of the Breast—Carcinoma.**—Three varieties are met with :

Spheroidal-celled, which forms (*a*) the most common malignant tumour of the breast, the well-known scirrhus cancer ; (*b*) encephaloid cancer.

Columnar-celled, forming the duct carcinoma, already referred to.

Squamous-celled, forming epithelioma of the nipple, which is very rare.

Scirrhus Carcinoma.—This occurs almost entirely in females, usually from middle life onwards. The older the patient, the better as a rule is the prognosis. The disease would seem to be associated with structural changes which take place at the periods of puberty, lactation, and the menopause. A history of injury is often given. This disease also follows Paget's disease, mastitis, and adenoma.

Except in old women, in whom it may be chronic, carcinoma, if untreated, usually kills in from one to three years.

Signs and Symptoms.—A hard tumour appears in the breast. It is usually small, and the breast is contracted. The tumour has the appearance of white, fibrous tissue, has an irregular edge, and is without a capsule. On section it cuts with a grating sensation. The cut surface is concave, which on scraping gives a distinct moisture or juice. The growth infiltrates the breast tissue, connective tissue, muscles, and finally the chest wall, the tissues being largely replaced by cancer cells.

Under the microscope the cells are found to be arranged in columns, three or four rows to each column, which divide and branch irregularly. A large quantity of fibrous tissue surrounds the columns of epithelial cells.

Clinically the disease may be divided into three stages : First, the period of early growth, in which a hard nodule appears in the breast, which may be felt by placing the hand flat over the breast and pressing towards the chest wall. It is quite painless, and usually discovered by accident. It is not fixed in any way, but if noted at the time it is found to be steadily increasing in size.

In the second stage there is a stony-hard growth present, with a nodular, irregular margin. The growth is fixed to the suspensory ligaments, joining it to the skin, and dragging on these it produces dimpling. It is also frequently fixed to the ducts of the nipple, and by dragging on these produces retraction of the nipple in one in four cases. The nipple of the affected side is often on a higher level than the other, owing to the breast being drawn up towards the pectoral fascia. The growth is fixed to the underlying muscle, so that it cannot be moved up or down ; and it may also be fixed to the chest wall. Later on it is fixed to the skin, through which it may ulcerate. Pain is present, but is of a neuralgic, intermittent character. The glands in the axilla are enlarged and hard, those in the posterior triangle of the neck and above the clavicle becoming affected later on. Nodules of secondary growth may appear on the skin over the breast or at some distance from it. The skin may be covered with moisture which exudes from the lymph capillaries, the lymph vessels being filled with cancer cells. In some cases the skin over the breast is hard and brawny, forming the **cancerous pachydermia** of Handley. This is due to obstruction of the lymphatics. It may spread for a considerable distance over the chest wall, when the cancer-infected skin becomes more and more infiltrated. The

chest wall becomes hard and leathery. To this the name of *cancer en cuirasse* is given. Occasionally there is a little blood-stained discharge from the nipple.

The third stage is that of cachexia, in which there is rapid wasting and bloodlessness. The skin is loose and yellow, the local growth has now become very firmly fixed, and crateriform ulcers have formed in the skin over it. These ulcers have a thin, watery discharge, and may become very offensive. The enlarged glands may produce swelling and pain in the arm owing to pressure, and solid œdema may make its appearance owing to the destruction of the lymphatics. Pain is constant and very severe. Metastatic growths may give rise to pleurisy or to ascites.

Extension of the growth may take place by direct invasion of tissue; by metastasis owing to permeation of the lymphatics, in which the cells grow in direct continuity with the primary tumour; or by direct invasion of the veins in the neighbourhood of the tumour.

What is termed **transcœlomic implantation** is the process by which the cancer cells, having reached the pleura or the peritoneum, become free in these cavities, and produce secondary growths on the surfaces of the contained organs.

Bilateral Scirrhus Carcinoma may occur by direct spread through the lymphatics across the middle line.

Diagnosis.—In the early stages no definite opinion can be given except after microscopical examination. The case should always be kept under close observation until a diagnosis has been arrived at.

From **mastitis,** carcinoma is distinguished by the history; the absence, in the former disease, of a tumour when the open hand is pressed against the chest wall; the feeling of the edge of the tumour, which is not hard and irregular, though there may be retraction and enlargement of the glands. A **fibro-adenoma** is freely movable in the breast-substance. It has a defined outline, the pain is neuralgic in character and worse at the menstrual period, and age incidence is earlier than in scirrhus. In **cystic disease** there is a long history; the tumour is elastic or fluctuation is present. In **chronic abscess** the pain is early, and there is central softening of the tumour.

Atrophic Scirrhus Carcinoma.—In this variety there is a great excess of fibrous tissue, producing an exceedingly hard tumour. It is generally present in women upwards of sixty years of age, and is of very slow growth. It is thought that it may be an example of an effort at natural cure by producing atrophy of the breast by fibrosis.

Encephaloid Cancer.—This form of carcinoma differs from scirrhus cancer in that the cells are larger and more numerous, and the stroma scanty, soft, and vascular. The growth occurs at a younger age, and frequently follows pregnancy or occurs during lactation. The tumour is very rapid in its growth, and its course short, usually about six months.

Signs and Symptoms.—A soft, elastic growth appears in the breast, and quickly increases in size till the whole gland is involved. The heat of the skin over the breast is increased owing to the vascularity of the growth, is early involved, assuming first an appearance like orange peel, and the tumour later breaks through as a fungating mass. The body temperature is raised. Involvement of the axillary glands occurs early.

Diagnosis is not as a rule a difficult matter. From acute mastitis it is distinguished in that an abscess forms in mastitis, on

opening which the condition subsides. From sarcoma it is distinguished by the tumour being round and circumscribed, by the absence of pain and the late involvement of the glands.

Operative treatment is of little avail.

Colloid Cancer.—This is really a degenerative process occurring in carcinomatous tumours, and not a distinct variety. The cancer cells form a substance formerly called "colloid," but now recognized to be "mucin."

Histologically a network of interstitial tissue is seen, which contains some broken-down cells and large spaces filled with mucin. At the margin of the growth the tumour retains more or less its normal appearance of a spheroidal carcinoma, and here and there through the growth some cells retain their ordinary characteristics (Lazarus-Barlow).

The tumour is round, smooth, and softer than scirrhus, is of slower growth and a lower order of malignancy. Secondary deposits are few. When they do occur, they may be colloid or of the ordinary type. The glands are enlarged at a late period of the disease.

Sarcoma.—Sarcoma of the breast is rare. It occurs at any age, but most usually between forty and fifty. It has no relation to lactation, and may follow fibro- or cystic adenoma.

The *round-celled* variety is very rapid in its growth, spreads by metastasis, especially to the lungs, and the glands are seldom implicated.

The *spindle-celled* variety is the less uncommon. It is of a slower growth, and is at first more or less encapsuled, apparently. The capsule is, however, not a true one, but consists of condensed fibrous tissue from which the growth cannot be shelled out.

Signs and Symptoms.—The tumour is elastic or semi-fluctuating, round and defined. There is no pain or retraction of the nipple, nor at first is the skin or glands involved. The growth may in the early stage be almost stationary; but when it begins to grow, it does so rapidly, and soon involves the whole gland. The skin then becomes red, with enlarged veins seen through it, and the axillary glands become enlarged and soft. The skin gives way, and a fungating mass appears.

John B. Murphy states that sarcoma of the breast is much more malignant than carcinoma.

Should pregnancy occur during the disease, the growth is stimulated. Dissemination occurs through the blood-stream usually to the lungs and pleura, but also to the liver, brain, and other internal organs.

Myxomatous degeneration occurs, with the formation of spurious cysts into which bleeding may occur.

TREATMENT OF MALIGNANT DISEASE OF THE BREAST.

When possible, the complete radical operation should be performed. This consists in the removal of the whole breast and a circumference of sound tissue, together with the pectoral fascia and the extension of the deep fascia over the upper part of the rectus and external oblique muscles, and the fascia covering the serratus and subscapularis muscles (Thompson and Miles). The pectoral muscles are removed so far as they are likely to be involved, and the

glands in the axilla, the pectoral and subscapular glands, and the supraclavicular if at all enlarged. Murphy states that the pectoral muscles should not be removed, as metastasis will not take place from muscle, but in the aponeurosis, and they protect the axillary contents from pressure and so obviate œdema and neuralgia. He transplants the pectoralis major into the axilla to fill the cavity and prevent excessive formation of cicatricial tissue.

Where much skin has to be removed, the difficulty of getting the edges to meet may be obviated by undercutting ; and if this does not serve, the deficiency may be made up by skin-grafting.

Before performing this very extensive operation, if there is the least doubt as to the diagnosis, the tumour alone should be excised and a section examined under the microscope.

In certain cases radical operation is contra-indicated, as when the skin is extensively involved, the tumour adherent to the chest wall, internal organs affected with secondary growths, or the constitutional debility too profound.

For such cases of **inoperable cancer,** a partial operation may be performed to remove the main body of the growth. This will have a good moral effect on the patient, relieve pain, and prevent hæmorrhage and septic changes. X-ray treatment also diminishes pain and prolongs life, and is especailly useful in recurrent nodules of the skin.

Large dosage with thyroid extract for producing absorption of degenerate cancer cells, injections of trypsin in cancer and of Coley's fluid in spindle-celled sarcoma, have all been advocated, and have produced benefit in certain cases.

In women before the menopause, oöphorectomy has been found of benefit in relieving symptoms and curing the growth for the time being. This method is founded on the belief that the removal of the ovaries and tubes interferes with the nutrition of the breasts, and so starves the new growth and arrests the progress by increasing the fibrous at the expense of the cellular elements (Beatson).

For the solid œdema of the arm sometimes produced by pressure of enlarged glands, the method of Handley, by insertion subcutaneously of silk threads, referred to under Erysipelas (Chapter VII.), may be found useful.

CHAPTER XXVI

INJURIES AND DISEASES OF THE ABDOMEN AND ITS CONTENTS

Injuries and their effects—The abdominal walls—The peritoneum; peritonitis—Subphrenic abscess—The stomach and duodenum; gastric and duodenal ulcers—Affections of the intestines—Affections of the appendices epiploicæ—Affections of the colon; diverticulitis; Hirschsprung's disease—Affections of the omentum and mesenteric glands—The vermiform appendix; appendicitis—Affections of the liver—Affections of the gall-bladder and bile-ducts—Affections of the pancreas—Affections of the spleen.

INJURIES.

Patients are liable to many accidents which entail injury to the abdominal wall and to the contained organs.

These may be received by means of direct or indirect violence whereby the walls may be wounded or crushed, and the organs bruised or ruptured; or the organs may escape injury altogether. This is especially true where the violence is indirect.

The diagnosis is sometimes difficult, and a mistake often leads to fatal consequences.

The prognosis will depend on many contingent circumstances, and in serious abdominal injury is always grave; but it has much improved since modern surgical procedure, which does not hesitate about opening the peritoneal cavity, has been adopted.

Here, as elsewhere, the state of health of the individual counts for much; and should there exist a tendency to tuberculous or malignant disease, the sequelæ may include these conditions.

In the normal condition the abdominal wall is soft and elastic; therefore violence is transmitted directly to the viscera. Should the individual be prepared for a blow, the muscles will become rigid, and to some extent bear the brunt of the violence.

The immediate danger of all abdominal injuries is **shock.** This may be so serious that the patient never recovers from it.

Hæmorrhage is the next danger, and may be diagnosed by the symptoms of shock not passing off, and by the increasing rapidity of the pulse.

Peritonitis may occur after twenty-four hours, and in the case of the hollow organs is the chief danger.

Injuries may be divided into—

Contusions and **wounds** of the abdominal wall without injury to viscera.

Rupture of abdominal muscles.

Injuries to abdominal organs.

This division, however, is more or less artificial, since it is seldom that one condition only is present, unless in very slight blows on the walls, and even in such a case an overdistended bladder or stomach may be ruptured.

Simple contusions of the abdominal wall range from a slight bruise to extensive tearing. The prognosis is good if injury to the underlying viscera can be excluded.

Superficial wounds of the abdomen heal well, and are not followed by any important sequelæ.

Rupture of abdominal muscles may be caused by excessive violence applied to the abdomen when the muscles are contracted. In such a case there will usually be injury to the viscera, and the prognosis is that of the internal injury.

Hernia is likely to occur after rupture of the abdominal muscles, especially in stout subjects. Shock is the most marked symptom.

Injuries to the abdominal viscera are likely to ensue from violence applied at right angles to the abdominal wall—*e.g.*, a kick, passage of a wheel across the body, a fall on a projecting body, or a crush between buffers.

DIAGNOSIS OF ABDOMINAL INJURIES.

Abdominal Walls.—If there be no external marks of injury, fracture of the lower ribs should be looked for. This may have injured the walls subcutaneously, and possibly also the viscera.

During the hours immediately succeeding an injury, muscular rigidity and pain are present.

Suppuration is sometimes found secondary to an injury, and may occur within the sheath of the rectus, between the muscular layers, or between the fascia and peritoneum. In the former case the pus may come to the surface at the umbilicus; the history, together with the position of the inflammatory signs, will serve to diagnose the condition. In the latter case the pus may be found in various situations, since the spaces communicate with one another; but as a rule it will be in the neighbourhood of the injury unless the case is an old-standing one.

Suppuration due to injury must be distinguished from that occurring as a result of disease of various internal organs, which is the more usual cause.

Pus in the prevesical space may simulate a distended bladder, but may be diagnosed by emptying the organ.

Pus in the iliac fossa behind the peritoneum is sometimes due to **osteomyelitis** of the pelvic bones following an injury.

Abdominal Viscera.—Early symptoms will be—Muscular rigidity, especially over the injured organ (this is much more marked than is the rigidity produced by injury to the abdominal wall only); pain and tenderness, which may be local or diffuse; dulness above the pubis, probably due to rupture of a distended bladder; in the flanks, to free fluid in the peritoneal cavity.

Organs of the Digestive System.—Nausea, followed by vomiting, is almost a constant symptom after injury of the **stomach** or **intestines.** It may continue for some time. If the vomited matter contain blood, it is indicative of stomach injury; while if it contain bile, the small intestine is probably involved. A sign which is considered of great importance—namely, absence of normal liver dulness—can, unfor-

tunately, seldom be elicited. If free fluid be present in the peritoneal cavity, it may be detected by percussion, with the patient in different positions; but it may be simulated if the intestines are full of fluid matter. The steadily rising rate of pulse is an early symptom of **perforation** of stomach or intestine; while if a blood count be taken, leucocytosis will be found to be present. There is usually gradually increasing distension of the abdomen, and if this is combined with inability to pass flatus perforation is indicated. Should blood be present in the stools, it is a certain sign of injury to the intestine; if the blood be of a dark colour, hæmorrhage is from the top of the intestinal track; while if bright it indicates a lesion lower down.

Urinary Organs.—Injury to the **kidney** usually produces considerable hæmorrhage, and if the wound connects with the peritoneal cavity symptoms of internal hæmorrhage are produced. If no such connection exists, there is a swelling over the lumbar region, and considerable pain, which may radiate along the ureter into the thigh upon the side injured. The most diagnostic symptom is the presence of hæmaturia. Blood as a rule will pass away into the bladder unless the ureter be torn or blocked. In order to diagnose the origin of the blood, it would be well to wash out the bladder and examine it with the cystoscope, or even to catheterize the ureter on the suspected side.

Ureter.—It is difficult to be sure whether the ureter is injured unless it be catheterized or until a tumour form along its course.

Injury to Solid Organs.—In these injuries the most dangerous symptom is hæmorrhage, which often produces profound collapse. There is usually pain and tenderness; some rigidity is often present. In the case of the **liver** the pain is sometimes found to radiate to the shoulders, and in injury of this organ jaundice is also often present.

When the **pancreas** is injured, pain is usually situated over the epigastrium, and distension of the upper part of the abdomen is sometimes present.

The **Spleen** is sometimes ruptured by external injury, and leads to serious hæmorrhage. The injury is difficult to diagnose with certainty, but may be assumed when signs of internal hæmorrhage are associated with injury in the splenic region, especially if the normal splenic dulness is increased.

INJURIES TO THE ABDOMINAL WALLS.

These may be slight or severe, penetrating or non-penetrating.

Contusions.—Results of even slight contusions to the abdominal wall may under certain circumstances, as before pointed out, be serious. Such circumstances are—distension of hollow organs, in which case even a slight injury will be found to produce rupture; this is especially true with regard to the stomach and bladder, the contents of which may be extravasated into the general peritoneal cavity, setting up peritonitis, which may end fatally. A comparatively slight blow on some of the solid organs may also produce alarming symptoms owing to partial rupture, hæmorrhage occurring into the peritoneal cavity. Apart from these conditions, contusion of the abdominal wall will not as a rule be serious, only producing slight pain, and a possible abrasion, in no way differing from that which may be sustained in any other part.

If the blow be fairly sharp and directed toward the epigastrium, there may be severe shock produced by injury to the **solar plexus.**

In some cases where a sudden fall or blow is experienced, injury to the abdominal wall may produce rupture of one of the constituent muscles. **Hæmatoma** sometimes follows, and may go on to suppuration and abscess formation. The abscess may point in various directions, as already stated, or at the injured place. The *Bacillus coli* is usually found present, and is thought to pass from a neighbouring coil of intestine injured at the time of the accident. Occasionally the peritoneum may be lacerated by the violence applied to the external wall.

Non-Penetrating Wounds.—These, if uncomplicated, may be regarded as elsewhere. If an artery, as the epigastric, is severed, it will lead to considerable hæmorrhage.

Penetrating Wounds.—The question to be decided in the case of a wound in the abdominal wall is whether an internal organ is injured or not. The usual practice now, if there be any likelihood of this, is to perform a laparotomy, but in many wounds, even though penetrating, no such injury is sustained. A very grave responsibility rests upon the surgeon as to the line of procedure he should adopt, for a mistake may mean very serious danger to the patient. Apart from the danger of injury to internal organs, there is always that of septic peritonitis to be remembered. This may be caused from within or without—in the former case from a ruptured hollow organ, and in the latter from the infected instrument which produced the wound. If diffuse peritonitis be produced, the symptoms will probably be localized or referred to the umbilicus. It soon, however, becomes diffuse, and is accompanied by the usual typical signs of peritonitis.

INJURIES TO INTERNAL ORGANS.

Injuries of the Stomach.—Rupture usually results from a blow or a fall on the epigastrium. The parts generally involved are the pyloric end or the greater curvature near the cardiac end. Rupture may also be produced by a penetrating wound, or a fall upon some sharp object. The liver and spleen may be injured at the same time. If the stomach be empty, it may escape by being moved aside; but if the crushing force be continued, severe injury will be produced by laceration of the mucous membrane, even where complete rupture does not take place. Severe hæmorrhage is often thus produced, and malignant disease of the stomach has been known to follow such an injury. It must always be remembered that a pre-existing pathological condition may render the injury much more serious in its results ; thus, for example, in a person suffering from ulcerated stomach rupture is more liable to take place than if the organ were normal.

Injuries of the Intestines.—Contusion of the intestine may be produced by a blow upon the abdomen, and will vary as to its effects. The severity of the injury will depend on whether the gut is distended or not. The small intestine may also be injured by being crushed against the vertebral column. The results of such injury may simply be bruising of the wall, setting up enteritis. This may quickly be recovered from, or destruction of the coats of the bowel may take place, especially where the mesentery has been injured. This is one of the conditions in which a retroperitoneal abscess may occur, when the part of the bowel injured is in that situation.

Rupture of the intestines may follow a more severe form of injury, and is often produced by a heavy weight, such as the wheel of a

vehicle passing over the abdomen. It is less likely to occur when the gut is empty. It is not necessarily at the point of impact that the intestine gives way; it may be at some distance from it. The prognosis in complete rupture is naturally very serious. The intestines may also be ruptured by means of a punctured wound. The symptoms are more or less serious according to the amount of extravasation. Gunshot wounds are less serious than they used to be, owing to the increased velocity of the projectile and its smaller size. A small bullet quickly traversing the intestines may not produce peritonitis, extravasation not occurring owing to the fact that the wound is very small, and that paralysis of the part seems to take place at once, giving an opportunity for adhesions to form.

The Rectum.—The rectum may be injured by bruises, by tearing, or by a penetrating wound. Owing to its situation, injury to this organ is not very often met with. It may occur as one of the results of a severe crush, when there may be a communicating wound between the bladder and rectum, a condition hard to deal with. It may also be cut into or through by the patient falling upon any sharp object. Occasionally a tear occurs from severe strain. This, however, is more usually met with in the physiological use of the organ than in the lifting of weights or such-like. Short of an actual tear or rupture, the walls of the rectum may be contused, a remote result of which, occasionally met with, is the loss of expulsive power, serious and obstinate constipation may thus be set up. A stricture may also develop at the site of injury, leading to alternate constipation and diarrhœa, and it may possibly be the site of a future cancer.

Injuries of the Gall-Bladder.—Rupture of this organ may occur from a blow, kick, or crush, and it may be opened by a penetrating wound. It should be remembered that occasionally a ruptured gall-bladder may be attributed to injury, while in reality it is the result of internal ulceration, the injury complained of being merely an exciting cause. If the bile passages be healthy, little effect will be produced by extravasation, as ordinary bile is not septic. It often happens that after an injury to the gall-bladder there is a gradual escape of bile, leading to an abscess formation which, being closed from the peritoneal cavity, may not produce any marked symptoms until constitutional effects are seen to be present.

Injuries to Solid Organs.—The **liver** may be injured by direct violence, such as blows on the abdomen or fracture of the ribs; by indirect violence, as in falls from a height upon the back or feet, or acute flexion of the trunk, as when a heavy weight falls upon the shoulders violently, compressing the abdominal contents. The same result may follow on falling from a height on the feet. Slight tears of the liver may be recovered from probably owing to adhesions being formed to the surrounding parts. If the rupture be more extensive, a fatal termination may result by hæmorrhage from the large venous trunks which are divided. A bullet wound sometimes produces complete destruction of the organ. If the liver be sclerosed, little damage will be done by a blow; if, on the contrary, it be enlarged, it is readily torn.

The **pancreas** may be crushed against the vertebral column, or may be injured, usually in common with other organs, by violence to the abdomen. The importance of the pancreas as a secreting organ should not be forgotten, and the fact that if totally disorganized it may lead to diabetes.

Rupture of the **spleen** often ends fatally. If the organ be enlarged, a slight injury will be sufficient to cause death; while pancreatitis, with hæmorrhage and suppuration, may follow as the result of injury caused by a fall or crush. In all cases of injury to the spleen there is great shock and pain, especially in the left hypochondriac region, and hæmorrhage which may prove fatal. If the case be less severe, the extravasated blood gravitates to the left loin, and from thence to the pelvis.

Injuries to the Kidneys and Ureters.—See Chapter XXXI.

TREATMENT OF ABDOMINAL INJURIES.

The treatment of **Contusions** consists for the most part in keeping the patient at rest, with the knees flexed, and in applying pressure by means of cotton-wool and a firm bandage. If any of the muscles are ruptured, the shoulders should be raised and the thighs flexed in order to approximate the ends. If this fails to bring them together, the muscles will have to be exposed and united by suture. Afterwards, when the patient begins to go about, it will be well for him to wear a belt in order to prevent ventral hernia. If any of the organs are injured, it may be necessary to open the abdomen and seek for the damage. If possible, the opening should be made over the seat of injury. If there is found to be hæmorrhage, this should be traced to its source and the bleeding stopped. If, at first, neither bleeding nor injury can be discovered, it will be necessary to make careful search in case there is rupture of the intestine. Any escaped blood or other matter must be removed, and drainage provided for.

With regard to **Wounds,** for an ordinary non-penetrating one the general principles of treatment apply. If, however, the abdominal cavity has been entered, or if there be suspicion of such a result, the wound should be disinfected, and sufficiently enlarged to remove any doubt on the subject. If the puncture has reached the peritoneal cavity, the wound should be opened up and the interior examined. If hæmorrhage or escape of intestinal contents is found, the injury must be sought for and dealt with according to circumstances. It should be borne in mind that more than one wound of the intestines may be present.

In some cases the omentum or a viscus may protrude, and, being exposed to infection, may lead to sepsis entering the peritoneal cavity. The protruding viscera should be cleansed, and returned to the abdomen if found to be sound; if not, it must be dealt with as required. It should be remembered that puncture of the wall of the abdomen frequently implies perforation of some viscus as well as the risk of hæmorrhage or peritonitis.

DISEASES OF THE ABDOMINAL WALL.

Cellulitis.—This may occur in two positions: First, in the **subcutaneous cellular tissue,** where the condition may be diffuse or give rise to a circumscribed abscess. It may be due to various causes, one example of it being the cellulitis caused by extravasation of urine. The treatment does not differ from that of cellulitis elsewhere. Secondly, it may occur in the **extraperitoneal cellular tissue,** and again may give rise to a diffuse condition or to abscess. It may be due to

diseased conditions of the urinary bladder, the condition at first simulating distension of the bladder; or of the uterus, appearing on the surface at either of the iliac fossæ. Other forms of cellulitis and suppuration may arise from the kidney, forming a perinephritic abscess in the loin; from the appendix; or from cancer of the cæcum, the suppuration will then appear on the surface at the right iliac fossa.

Where an abscess forms, it usually makes its way to the surface. There are other causes of cellulitis and abscess formation of the abdominal wall connected with various injuries and diseases, which however, are too rare to require detailed description.

The abscess should be opened and drained on ordinary principles. Further than this, however, the initial cause must be sought for and treated.

Tuberculous Abscess.—This may arise from disease of the vertebræ or of a rib, the pus burrowing forwards, and usually pointing at the side of the abdomen. Having found a focus of disease in a rib, it must not be concluded that there may not be disease existing also in the vertebræ.

Actinomycosis.—This usually is secondary to similar disease of the intestines. It usually shows itself as a hard, irregular swelling, gradually becoming soft, which eventually ruptures upon the surface, discharging pus which contains the characteristic yellow granules. The condition is treated on general principles.

Tumours of the Abdominal Wall.—A **Lipoma** may spring from the subcutaneous areolar tissue, or a **Fibroma** grow from the covering of the muscles or the aponeurosis of the abdominal wall. The latter tumour should be removed together with the immediately surrounding tissue; the resulting gap in the wall is then carefully sewn up, and the patient kept in bed for some little time, in order to avoid ventral hernia. **Secondary Malignant Disease** may occur, usually in the form of multiple nodules seated in the subcutaneous tissue or skin. **Warts** or **Moles** are met with which at times take on malignant change.

AFFECTIONS OF THE UMBILICUS.

Patent Meckel's Diverticulum.—This is a persistence of the vitelline duct, which passes from the ileum, a little above the ileo-cæcal valve, to the umbilicus, and usually becomes obliterated about the eighth week of intra-uterine life. When this duct remains patent, it may give rise to various conditions, such as a fistula, which discharges mucus and occasionally fæcal matter on the surface. It may also be prolapsed through the umbilicus and form the beginning of the opening of a hernial protrusion, and thus cause obstruction of the bowels. The diverticulum may also cause obstruction by becoming wound round a coil of intestines.

The mouth of the duct should be closed; and if fæcal matter is discharged through the opening, the diverticulum should be removed and its opening into the ileum closed. It sometimes happens that the duct is closed internally and not externally, so that a protrusion of the mucous membrane occurs, and may form a pedunculated tumour, which it will be necessary to remove. The duct is sometimes closed at both ends, but remains open in the centre, and, becoming distended with fluid, forms a cyst.

Urachal Fistula.—It occasionally happens that the duct of communication between the urinary bladder and the allantois remains

patent, and extends into the umbilical cord, the result being that, on separation of the cord, a fistula is formed which discharges urine. If it does not close, the patent duct should be dissected out, and its opening in the bladder closed by sutures. This duct may remain pervious to the umbilicus, though closed externally, and infection may extend into it from the bladder and cause an abscess which bursts at the umbilicus, with discharge of pus and urine. Cysts may develop in the course of the urachus owing to the duct being obliterated at both ends, but open in the middle.

Tumours of the Umbilicus.—These are usually dermoids, papillomata, fibromata, or malignant disease. They do not call for any special mention. They should as a rule be removed.

Pathological Fistulæ.—The most common of these are biliary fistula, which usually follows inflammation of the bile-ducts ; urinary fistula, which follows cellulitis or abscess in the space of Retzius ; and fæcal fistula, which follows various conditions, such as strangulated umbilical hernia, or any condition which causes ulceration of the intestine.

DISEASES OF THE PERITONEUM.

Peritonitis.

This is an inflammation of the peritoneum, and arises from divers causes. The condition varies from an evanescent one which is helpful to the bodily health by reason of the removal or isolation of some substance or substances which might cause infection, to a grave disease which may in itself prove fatal. It may be part of a general constitutional trouble or it may be entirely local.

Causes.—Infection may arise from without or within. In the former case it is caused by penetrating wounds, which introduce infective organisms or liberate them from the digestive tract, either by piercing it or by damaging the walls so that the organisms can pass through. From within it arises from the stomach or intestines, owing to injury, disease, or perforation. It may come from the Fallopian tubes usually consequent on gonorrhœa, or from the uterus during the puerperium. The infection may also be carried in the blood-stream, as in tuberculous, rheumatic, and pneumococcal infections.

The micro-organism usually present in non-infective peritonitis is the *Staphylococcus albus*, which escapes from the wall of the intestine when in any inflammatory condition, and gives rise to phagocytosis and adhesions, which limit the spread of peritonitis due to other organisms. The *Staphylococcus aureus* is sometimes found, and is responsible for a violent type of the disease. The *Streptococcus pyogenes* is usually found in peritonitis resulting from wounds, but it also comes from the intestine, and produces a virulent form of the disease. The *Bacillus coli* is usually present in all cases, and comes generally from the intestines. The micro-organisms of pneumonia and tubercle usually found in peritonitis occur as a result of these diseases in other situations, and reach the peritoneum owing to a blood infection or to ulceration of the intestine.

In a number of cases the infection is a mixed one.

It must be remembered that peritoneal infection may originate in any of the organs covered by, or near to, the peritoneum. That which is secondary to appendicitis is most frequent. Probably the next

most frequent cause in the intestinal tract is perforating gastric or duodenal ulcer. Then come pathological conditions in the gall-bladder, liver, or pancreas, from which infective processes may spread to the peritoneum.

Pathology.—The vessels lying beneath the peritoneum become dilated. There is exudation of lymph upon the peritoneal surface, which becomes adhesive. Next there is exudation of serum, leucocytes, and bacteria, to form a purulent exudate, which gravitates to the lowest part of the abdominal cavity. There is a small round-celled exudation beneath the peritoneum, and in violent types of the disease the endothelium is shed, and the lymph, becoming organized, forms permanent adhesions which mat together neighbouring viscera. The omentum usually becomes adherent at the position of greatest inflammation.

Symptoms.—These vary with the type of the disease. In acute diffuse peritonitis they are local and general. Locally there is great tenderness and rigidity of the abdomen ; pain, which is first local at the site of the original focus of disease, and later becomes general. There is no abdominal breathing, tympanites is present, and there is dulness in the flanks after the first two or three days. The patient lies with legs drawn up, suffering from profound shock, with a typical drawn, anxious expression on the face ; the pulse is small, quick, and wiry ; the respirations are shallow and much increased in frequency ; the temperature is at first normal or subnormal, but later is raised ; in very bad cases it usually falls before a fatal termination ; there is vomiting of a regurgitant kind ; the matter vomited may be dark or fæcal as the disease advances ; distressing hiccough may be present, and constipation is often marked.

Treatment.—The general constitutional treatment consists of rest and hot fomentations applied to the abdomen. Turpentine enemata are often useful, and drachm doses of sulphate of magnesia, given frequently, may sometimes overcome the persistent constipation, if there be no obstruction. Opium should be avoided at first, as it renders diagnosis difficult and produces paralysis of the intestines. Saline infusions, given either by the rectum or subcutaneously, have been recommended.

Operative treatment should be adopted at once when evidence of acute septic peritonitis is present and there is a rapidly rising pulse. It consists in opening the abdomen over the seat of injury, if possible, where one exists, and in the mid-line if there is no injury or if its position is unknown. The cause of the peritonitis should then be sought for, and dealt with according to circumstances. All free fluid should be removed from the abdomen by means of sponges, the peritoneal surface being handled as little as possible. Irrigation should not be carried out if local peritonitis only exists, as it tends to diffuse the infection ; but it may be adopted when there are no adhesions, and the condition is one of general peritonitis, though the practice is losing favour. Drainage may be carried out by means of tubes, and is specially called for when pus or fæces is present in the peritoneal cavity. Additional openings may be made above the pubes for Douglas's pouch, in the loins, or in the roof of the vagina to drain the pelvis in the female.

After-Treatment.—The patient should be placed in a bed which has the head raised about a foot and a half, while he is propped up by pillows in a sitting position, in order that any fluid remaining in the abdomen

may gravitate into the lowest part—viz., the pelvis. This is called "Fowler's position." Saline solution may with advantage be introduced in order to restore the proper blood-pressure and to increase the action of the kidneys and skin. It may be passed into the rectum by means of a rubber tube connecting with a douche-can, which is placed about a foot above the pelvis, or it may be introduced into the subcutaneous cellular tissue or into the median basilic vein. It may be necessary to wash out the stomach should vomiting continue. It is necessary that the bowels should be moved as soon as possible. Sulphate of magnesia in saturated solution may be injected into the bowel before completing the operation (McCosh). Calomel in small doses or in one large dose may also be used.

Local Peritonitis.—The cause of this form is usually an abdominal or visceral injury with infection of small virulence. The various conditions giving rise to it are—contusion of the abdomen; subphrenic abscess; malignant disease; a "leaking" gastric ulcer or gall-bladder; ulcer of the intestine; appendicular, pelvic, peritoneal, or ovarian inflammation. The **Symptoms** are local pain and tenderness, referable to the organ involved, with local induration and swelling giving dulness on percussion, and later signs of a local abscess. The **Treatment** is rest and hot fomentations at first. When the diagnosis is established, operation should be carried out in order to remove, if possible, the initial cause of the condition.

Non-Infective Peritonitis.—This is a form of the disease which is caused by mechanical irritation, such as may arise from the leaving in the abdomen of an instrument or a swab of gauze. It may also be produced by chemical irritation, as from extravasated bile or the contents of a ruptured ovarian cyst. The peritoneum becomes red and slightly rough, and there is some exudation of serum and lymph, which may be entirely reabsorbed or give rise to adhesions. The **Symptoms** of this type of the disease are slight, for as a rule, an aseptic foreign body remains in the peritoneal cavity for a long period without doing very much harm.

It has been shown that a white staphylococcus of a low degree of virulence is usually present in such cases.

Chronic Peritonitis.—This form is usually due to some constitutional disorder, especially tuberculosis or syphilis, and actinomycosis; but there is also a simple variety, which may not be in itself a disease, but rather caused by certain changes in the peritoneum attending intra-abdominal diseases. A local fibrous peritonitis the result of mild septic invasion may come under this heading, and also the simple peritonitis, the origin of which is not very well understood, there being no clear factor for its causation. It is, however, associated with rheumatic fever and Bright's disease, so that it is probably of toxic origin. There is usually marked ascites, and the peritoneum is thickened.

Tuberculous Peritonitis.—This is most often met with in children or young adults, generally secondary to other lesions of a like nature, especially in the intestine, Fallopian tubes, or the glands of the mesentery, the peritoneum becoming infected by direct extension. Tuberculous disease of the lung or pleura may travel to the lymphatics of the peritoneum, while tuberculosis of the bronchial glands, bones,

joints, or genito-urinary organs, may be carried by means of the blood-stream. The disease may occur as a diffuse miliary invasion of the peritoneum, the tubercles occurring in the course of the bloodvessels. This form is usually part of a general tuberculosis, constitutional symptoms perhaps overshadowing the local ones. The surgeon usually can do nothing for this condition, which is generally fatal.

The chronic forms of tuberculous peritonitis may be divided into those with exudation of fluid and those without. The first form is called **tuberculous ascites.** The exudate is serous in character, and may be diffuse or confined by adhesions to a limited area ; the former is the more common. The patient loses strength, while the peritoneal cavity slowly becomes filled with fluid. On palpation it may be possible to feel enlarged glands or the great omentum, which is often changed into a large hard mass occupying the upper part of the abdomen, which becomes prominent, with tense, glazed skin and distended veins. This, associated with the wasted condition of the rest of the body, gives a typical picture. The fever is usually of the hectic type.

Treatment.—Improved hygienic conditions with open-air treatment give favourable results. Operative interference ought to be postponed until the other has had a chance of effecting a cure. If it does not do so, an incision should be made in the centre line of the abdomen, below the umbilicus, and the fluid allowed to drain away. The peritoneum is usually studded over with tuberculous nodules of various sizes. If any of these have broken down, they should be removed with a sharp spoon, while any primary source of infection which can be detected should be removed. In many cases drainage is not required. The extraordinary improvement which sometimes follows laparotomy is most probably due to the bactericidal properties of the peritoneum being increased by the reaction following the operation. Tapping is not of much value in these conditions, unless as a temporary expedient.

Encysted tuberculous ascites is not common. If present, it is usually in later life and in the female sex. The area of infection is closed by adhesions, which may become thick and strong. The symptoms of this condition somewhat resemble an ovarian or cystic tumour. It is best treated by making an incision over the swelling, the fluid being removed, and the wound closed.

As pointed out by Thomson and Miles, draining the peritoneum for either the cystic or the diffuse form of tuberculous ascites is liable to be followed by a discharging sinus or fæcal fistula.

Occasionally there may be a **purulent form** of tuberculous peritonitis. It is rare, but is sometimes met with in young females. There is great wasting, with tenderness of the abdomen, the fever being of the hectic type. The pus contained is usually green, and no tubercles are felt in the peritoneum. The abscess should be opened at once.

The **dry form** of peritoneal tuberculosis is characterized by the formation of adhesions, which mat together the viscera. The abdomen is not much distended, and the general symptoms are slight. Dulness may be detected on percussion. It is, however, irregular, and alternates with resonance, while a doughy feeling is given to the hand on palpation. The omentum is sometimes felt as a sausage-like tumour, running transversely across the abdomen. In some cases there is fluid between the adhesions, which does not change its position on posturing the patient. Prognosis is not good, and there is no

tendency to spontaneous recovery. The complications are various. They are—abscess formation with external or internal rupture, the formation of a fæcal fistula, and the gradual development of intestinal obstruction. The more serious cases are usually associated with ulceration of the bowel, and pulmonary tuberculosis may also be present. Treatment is not satisfactory. The X rays have been found useful, and laparotomy may be carried out; but it is difficult on account of the great matting together of the intestines, and efforts to unravel them frequently result in tearing the bowel. Where, however, the tuberculous infection is limited over the primary focus, the condition is more favourable.

Actinomycosis.—This usually arises from pre-existing disease of the intestine, often of the cæcum. A large mass is formed, which consists of intestine, omentum, and exudate. It is at first hard, but gradually becomes softer, and forms an abscess which bursts externally, and a sinus is often left. Treatment is carried out by the X rays, removal of the infected mass as far as possible, and the administration of iodides.

Malignant Disease.—Cancer of the colloid variety and other forms of primary malignant disease are sometimes met with in the peritoneum. It is, however, more usually the site of secondary growths from the stomach, ovary, or intestine.

Symptoms.—Ascites is usually present; wasting is marked; a tumour can often be felt through the abdominal wall or *per rectum*. If some fluid be withdrawn through an aspirating needle, it is usually found to be blood-stained, and cancer cells may be demonstrated.

Hydatid Cysts.—These are occasionally met with in the peritoneum or extraperitoneal tissue. The diagnosis is difficult. The treatment is to open the abdomen, puncture and empty the cysts, or, if possible, to remove them.

Foreign Bodies.—As already stated, it sometimes happens that some foreign body is left in the abdomen during an operation, and, if aseptic, becomes encapsuled and gives rise to no symptoms. It may, however, do so, causing pain and general disturbance. Hard bodies, left in the abdomen, sometimes make their way into the bowels and are discharged *per rectum*, or they may be the cause of local abscess, which, rupturing externally, may lead to the expulsion of the foreign body. The X rays should be employed to locate a solid body, and if located, the abdomen should be opened and the body removed.

Extraperitoneal Tumours are sometimes met with. They are usually of a simple nature, such as lipoma; but sarcoma sometimes occurs as a retroperitoneal tumour, and a congenital ganglionic neuroma is sometimes met with in children. Its origin is the sympathetic nervous system, and, if indicated by the symptoms, removal may be attempted.

The Solid Tumours of the Mesentery.—These usually arise in the extraperitoneal tissue; they are generally fatty, may increase in size and push themselves between the layers of the mesentery, becoming covered by peritoneum. These tumours are usually felt as a central swelling, with a considerable amount of movement. The tumour may be shelled out after dividing the covering peritoneum.

Cystic Tumours of the Mesentery.—The most common of these is the cystic lymphangioma. It is filled with a thick white fluid, and may become hard in process of time. Dermoids, hydatids, and other cysts of fœtal origin, may be met with. Diagnosis is not easy, and

is usually not made definitely until the abdomen is opened. The cyst should be removed if possible.

THE OMENTUM.

Twisting of the Omentum.—The cause is not known. The blood-vessels become constricted, so that part of the omentum is strangulated and may become gangrenous. The condition is usually associated with hernia. There is violent pain with retching or vomiting, and the temperature is raised. On examination the abdomen is found to be tender, and sometimes a tumour may be made out. The treatment is to open the abdomen and remove the strangulated portion of the omentum. The hernia, if present, is treated at the same time.

Tumours and Cysts.—These are usually dermoids or lymph tumours. They are not common in adults. The diagnosis is difficult ; the treatment is to remove them. Solid tumours in this situation are usually malignant and accompanied by ascites.

Ascites.—This term indicates accumulation of fluid in the sac of the peritoneum. It arises in the course of disease of the heart or kidneys, when it is usually part of a general dropsy. In cirrhosis of the liver it arises from obstruction of the portal circulation. The condition accompanies many diseases of the peritoneum, such as tuberculous, malignant disease, etc. There is a tendency to a fibrous thickening of the peritoneum, and adhesions may form, the sac of the peritoneum being thus divided into several compartments. The condition is recognized by the presence of free fluid in the cavity, giving rise to dulness on percussion, and a fluid thrill may be detected. The abdomen is enlarged in all directions. The fluid, so long as it is unbound by adhesions, lies in the most dependent part, and will therefore change with the position of the patient. The action of the heart and lungs is interfered with where effusion is considerable, and dropsy also occurs in the lower limbs.

Treatment.—The cause of the condition should be cured if possible. In addition to this, it is frequently necessary to remove the fluid in order to relieve pressure. This may be done by tapping the abdomen by means of Southey's tube or an ordinary trocar and cannula, which is pushed into the peritoneal cavity a little to one side of the centre line below the umbilicus. The fluid should not be allowed to come away too quickly, and it is well to have a bandage round the abdomen, which can be tightened as the fluid is drawn off. When the condition is due to obstruction of the portal circulation, the Talma-Morrison operation may be performed. This aims at promoting the formation of an anastomotic circulation through the omentum and parietal peritoneum.

THE MESENTERIC GLANDS.

Tuberculous Disease is common, and is usually accompanied by a like condition of the small intestines. It is generally met with in children (*tabes mesenterica*). Little can be done for the condition beyond trying to improve the general health of the child. The group of glands in the ileo-cæcal region is sometimes diseased in adults. Frequently there are no symptoms, and a swelling may be accidentally detected in the abdomen. More usually, however, the disease attacks the peritoneum, giving rise to a local peritonitis causing adhesions, or a band which may produce strangulation. Cicatricial changes in the

ileo-cæcal mesentery may cause it to be shortened, thus interfering with the normal movement of the gut, and obstinate constipation may thus be set up. Should the tuberculous glands burst and discharge their contents into the sac of the peritoneum, acute peritonitis will be produced.

Treatment.—General hygienic treatment and the injection of tuberculin should be tried. Operation may be undertaken, and the contents of the glands removed to try and prevent dissemination of the tuberculous infection to other regions.

Subphrenic Abscess.—This term is applied to a collection of pus beneath the under-surface of the diaphragm.

The intraperitoneal part of the space is divided into two by the falciform ligament of the liver, each of which is again divided into an anterior and posterior space by the coronary ligament. The anterior is the larger of these two spaces.

The pus may gather in many of these compartments; the pus may collect in the cellular tissue outside the peritoneum, on the right in the space between the layers of the right coronary ligament, on the left in the tissue around the upper end of the kidney, later the peritoneum is stripped off the under-surface at the left part of the diaphragm. In some of the cases, estimated at about one-third, the abscess is secondary to a stomach or duodenum ulcer ; the appendix and liver together are responsible for about an equal number of the cases; and the rest owe their origin to diseases of the kidney, the Fallopian tube, intestine, or lung.

The abscess is situated on the same side as the diseased organ from which the infection comes. The contents of the abscess are pus, and gas is sometimes present, being derived from a perforation of a hollow organ or from bacterial decomposition within the abscess.

The pleura and lung may become affected through the diaphragm.

When untreated, the abscess usually bursts into the cavity of the pleura, the stomach, intestine, or the general peritoneal cavity, and occasionally on to the skin surface.

The abscess which is consequent upon a gastric ulcer is as a rule intraperitoneal, and is situated under the left vault of the diaphragm. When the perforation of the stomach occurs on the anterior wall or near the lesser curvature, pus forms in the left anterior intraperitoneal space ; if in the posterior wall, the pus gathers in the left posterior intraperitoneal space. Perforation due to duodenal ulcer occurring in the right lateral wall near the pylorus usually infects one of the compartments under the right vault of the diaphragm.

When the abscess follows disease of the appendix, it is usually on the right side. When extraperitoneal it is owing to upward spread of infection in the cellular tissue or the lymphatics behind the ascending colon, or between the layers of the ascending mesocolon ; when intraperitoneal it usually follows general infection of the peritoneum, as a stranded collection of pus.

When following liver abscess, the pus collects usually on the right side, and is extraperitoneal.

Symptoms.—The abscess may form early, and it may be acute, latent, or chronic. Usually some time elapses between the primary cause and the appearance of symptoms of subphrenic abscess. There is usually fever of a remittent type, vomiting, loss of appetite and strength, and an increasing leucocytosis. Pain is usually a prominent

symptom, and is referred to the place at which the abscess develops. The tongue is dirty, there is great perspiration, and sometimes rigors are present. Respiration is interfered with, and there is tenderness over the lower ribs, elicited by pressing on the thorax on either side. In a number of cases abdominal swelling, due to the abscess or the displaced liver, is noticed, which does not descend on inspiration, on account of adhesions. When the abscess is on the right side, there is an extension of liver dulness, which corresponds to the upper displacement of the diaphragm by the pus. When gas is present in the abscess, there will be a tympanitic note above the dulness, due to the pus and liver, and below the normal resonance of the lung. When the abscess forms on the left side, the left lobe of the liver is displaced downwards. When gas is present in an abscess upon the left side, a tympanitic note is present above the pus, and stomach resonance below it.

Treatment.—Puncture with a long aspirating needle should be made in order to confirm the diagnosis before proceeding to operation. If pus is found, and the abscess projects below the anterior costal margin, it may be opened from the front. Generally the transthoracic route should be undertaken.

THE STOMACH AND DUODENUM.

Examination.—The stomach may be examined by inspection, palpation, percussion, and auscultation.

The combination of auscultation and percussion, by means of light taps at one part while the stethoscope is applied to another, enables the examiner to make an outline of the stomach when dilated with gas. By lavage, employing the stomach-pump, the capacity of the stomach may be tested. It is normally from 2 to 3 pints, and is greatly increased by dilatation or atony, and decreased by malignant disease, and occasionally by adhesions. The contents of the stomach may be examined for blood, pus, hydrochloric or lactic acids, and sarcinæ; and the amount of free hydrochloric acid may be estimated. For the purposes of examination the stomach is sometimes distended. This is best done through a stomach-tube by means of a syringe or siphon; or it may be accomplished by giving 1 drachm of bicarbonate of soda, and afterwards some tartaric acid: this distends the organ with carbonic acid gas.

Test Meal, etc.—This is useful in various conditions of the stomach; it usually consists of 6 ounces of toast or meat, with a little water or weak tea without milk or sugar. The stomach should be empty after this meal in three to four hours. After an hour and a half the stomach contents are withdrawn and analyzed, especially as to the presence of free hydrochloric acid, lactic and butyric acids. In **gastric ulcer** free hydrochloric acid is usually present in excess, and in **gastric cancer** it is usually absent. When the pylorus is obstructed, certain of the more indigestible fragments of food, as seeds, etc., may be detected after long intervals.

It is found that salol is not decomposed until it reaches the

duodenum, after which it can be detected as salicyluric acid in the urine.

Illumination of the stomach, which shows its outline when it is distended with fluid, may be carried out by means of a small electric lamp placed within a flexible tube. After giving 2 ounces of bismuth carbonate and a little bread and milk, a shadow is thrown on the fluorescent screen, and may serve to distinguish between the cavity or reservoir of the stomach and the contracting pyloric antrum.

FOREIGN BODIES IN THE STOMACH.

Various articles are swallowed from time to time, especially by children and by lunatics. These may vary from tooth-plates to such things as needles, pins, or hair balls.

Symptoms.—There may be no symptoms, or they may consist of pain or tenderness over the region of the stomach, with vomiting and a passage of blood from the bowel. An X-ray photograph will often reveal the article present.

Treatment.—It is not wise to operate at once if a foreign body is not causing inconvenience, as with a suitable diet it may pass away by the bowel. If thought necessary, the stomach is opened and the body removed.

STENOSIS OF THE PYLORUS.

This, which is usually a congenital condition, consists of a contraction of the pylorus, the rest of the stomach being dilated. There is a circular thickening about 2 inches long, through which it may be impossible to pass even a probe. It is caused by a fibrous growth of the submucous tissue, together with hypertrophy of muscle. The rest of the stomach wall may be thickened or attenuated.

The **Symptoms** usually come on soon after birth. There is vomiting, the matter containing no bile, distension of the stomach, while a hard tumour may be felt at the pyloric end. There is pronounced and rapid wasting and an excessive degree of constipation. Peristaltic waves are often to be seen or felt passing from the left to the right side.

The condition may persist in adult life.

Treatment.—The diet should be administered in small quantities, the food consisting for the most part of peptonized milk or meat juice. Nutrient enemata may also be used. Small doses of opium give good results by relieving the spasm, and lavage of the stomach prevents decomposition. Operative treatment consists of gastro-enterostomy, for preference, or of pyloroplasty. In certain cases in which there is only partial stenosis it may be possible to distend the pylorus with the fingers.

GASTRIC ULCER.

This may be **acute** or **chronic.** The acute ulcer may be multiple; it may occur as a **simple erosion,** with little tissue loss; severe bleeding may occur owing to erosion of the small arteries of the stomach wall; or it may take the usual form of the **acute round ulcer.** This is small, and may develop in any part of the stomach, but is more frequent on the posterior wall or the lesser curvature. The ulcer is usually cone-shaped; the edges are sharp and clean-cut. There is little

PLATE LVII.

GASTRIC ULCER COMMUNICATING WITH THE DUODENUM, WHICH LIES BEHIND THE PYLORIC PORTION OF THE STOMACH.

(Museum, Queen's University of Belfast.)

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induration of the base, and healing occurs frequently without great contraction.

The **Causation** of these ulcers is not well understood. It is thought to be due to certain blood-conditions, such as anæmia, which may predispose to the condition, and auto-digestion of the stomach wall; to hyperacidity, which leads to erosion; to the presence of certain gastric poisons; or to changes in the bloodvessels predisposing to thrombosis.

The formation of acute ulcer of the stomach is associated with young women of the anæmic type.

Symptoms.—There are symptoms of acute indigestion, with **pain** of a sharp, cutting character. This comes on soon after meals, and **vomiting** may occur, which relieves the pain. There is usually one **tender spot** over the stomach. There is often a history of the vomit being like "coffee-grounds," which indicates some **bleeding** of the stomach wall. The bleeding may be much more than this, however, and may lead to a fatal end, though this is not usual, as the hæmorrhage is generally from small vessels. Perforation may occur, and this leads to general or local peritonitis—the former when the anterior wall of the stomach is involved. As already seen, subphrenic abscess may also result.

Treatment.—Rest in bed and special milk diet; in very extreme cases feeding by the rectum may be carried out. Certain alkalies, such as soda and magnesium, are of service, but bismuth has somewhat lost its reputation in this connection. When the case is not benefited by prolonged rest and medical treatment, or relapses after it, and when the bleeding has been recurrent, gastro-enterostomy should be performed. If perforation has taken place, the same operation is carried out after the initial shock has passed off.

CHRONIC GASTRIC ULCER.

The characteristic of this ulcer, as compared with the acute, is that it is usually single, and occurs in men more frequently than in women. The position is usually at or near the pylorus, and may be on the anterior or posterior wall; the latter is the more common. The edges are rounded, indurated, and piled up. The base is often adherent to the stomach. Great contraction usually follows the healing of this ulcer; in its process it may erode large bloodvessels outside the stomach, and secondary hæmorrhage may result. Bleeding is more fatal in the case of these ulcers than in the acute variety.

Symptoms.—They may be those of chronic dyspepsia. The pain is a dull aching one, and usually occurs within an hour after food. It is generally relieved by vomiting; it may extend to the back as well as over the stomach, and is not usually amenable to treatment by dieting or medicine; it is liable to recur. The exact position of the pain will depend upon the position of the ulcer. A. B. Mitchell states that in his experience pain in gastric ulcer radiating to the back is associated with an ulcer on the lesser curvature or on the posterior surface of the stomach, and that there is no tender spot in a chronic indurated ulcer. It is found that in an ulcer on the anterior wall pain is relieved by lying on the back, and, on the other hand, an ulcer situated in the posterior wall is relieved by lying on the face.

There is progressive wasting, which is usually in proportion to the severity of the dyspepsia.

The vomited matter is frequently decomposed, especially if there is gastric dilatation; it contains an excess of free hydrochloric acid.

Pyloric stenosis may lead to dilatation of the stomach. Hour-glass contraction is consequent upon the healing of a large ulcer, especially when situated near the middle of the stomach, and this leads to dilatation of the proximal portion.

Adhesions may occur which bind the stomach to the pancreas and the great vessels behind, to the parietes in front, the liver and gall-bladder above, and the colon below.

Treatment.—In well-established chronic ulcer, medical treatment is not of much avail, but may be tried. Mitchell emphasizes the importance of washing out the stomach every night. Failing relief, surgical treatment, usually gastro-enterostomy, should be undertaken. The cures following operation are estimated at 80 to 90 per cent.

COMPLICATIONS OF GASTRIC ULCERS.

The principal complications in the **acute ulcer** are—perforation; peritonitis, which may be local or general; abscess formation, which may lead to subphrenic abscess. There may also occur abscess of the liver, pancreas, or spleen, and bleeding may arise at any time during the course of the disease, the blood being vomited pure or as coffee-grounds, or passed as a tarry material (melæna). In **chronic ulcers** the complications are—peritonitis, usually local; bleeding, the blood being passed from the bowel or contained in the vomit; hour-glass stomach; stenosis of the pylorus; fistula; tetany of the stomach; while inflammation of the pancreas and bile-ducts, and malignant disease, may also be met with as results of chronic ulceration of the stomach wall.

Perforation.—If this is acute, it usually leads to diffuse peritonitis; if subacute, to local peritonitis and the formation of an abscess. If chronic, it usually causes perigastric adhesions. Perforation occurs in about 20 per cent. of all cases of gastric ulcer. The site is usually the anterior wall, near the cardiac end in acute ulcers, and the pyloric in chronic ulcers. Is is most frequent in young females.

The size of the perforation may vary from little more than a pin-head, so that it is often difficult to find, to one measuring about $1\frac{1}{2}$ inches. In most cases there is a history of preceding indisposition and of vomiting coffee-grounds matter. There is pain, which is usually sudden and severe, over the region of the stomach, and shock occurs, which is usually severe and increasing for a time, but passes off in a few hours. The vomiting, when it occurs, is slight, and some blood-stained matter is ejected. The upper part of the abdomen is found to be rigid, hard, and tender; the liver dulness may be obscured by the presence of free gas, and dulness also occurs in the flanks, which moves in different postures. Local peritonitis is present in the epigastrium, about the pylorus, or in the right iliac fossa, in subacute cases.

Diagnosis may be a matter of difficulty in the absence of any previous history of dyspepsia, and is sometimes not made until after the abdomen has been opened. As a rule, however, it is not difficult, the history and examination pointing to the condition present.

Treatment.—The abdomen should be opened in the mid-line, and the anterior surface of the stomach carefully examined. Subsequently

an opening is made in the gastrocolic omentum, through which the posterior surface may be examined. The ulcer, having been found, may be excised and the stomach closed; or the ulcer may be invaginated into the stomach, and the walls brought together on the outer side; or, as is now almost invariably done, gastro-enterostomy performed, especially when the ulcer is chronic or stenosis of the pylorus is present. When there is effusion of stomach contents into the peritoneum, this should be carefully wiped out, and the peritoneum may be irrigated. If peritonitis has occurred, it is advisable to leave some drains in certain positions, as the pelvis and right iliac fossa.

The results of the operation will depend a good deal upon the fulness or emptiness of the stomach at the time of perforation, the distance of time between perforation and operation, the size of the perforation, and the amount of vomiting present.

Gastric Hæmorrhage.—This may result from an injury, the presence of aneurism, certain functional conditions, or some general disease, as cancer, cirrhosis of the liver, cardiac disease, etc. Gastric ulcer is, however, the most usual cause. The source of the bleeding is from capillaries in most acute forms of ulcer, and from arteries in the chronic form; the latter is, of course, the more severe. The splenic, gastroduodenal, and the right gastro-epiploic, are the vessels most often eroded. The hæmorrhage may vary from brown coloration of the stomach contents to the ejection of almost pure blood.

Treatment.—Perfect rest, ice to the epigastrium and to suck. Adrenalin may be injected or given by the mouth, or ergotin may be injected. A. B. Mitchell prefers an injection of 20 c.c. of normal horse serum, repeated night and morning, or oftener if required. There should be perfect functional rest for the stomach, feeding being carried out by the rectum. If operation is necessary, the stomach should be opened and the bleeding stopped. In many cases it will be advisable to perform a gastro-enterostomy at the same time.

When the bleeding is from a chronic ulcer, there are usually signs and history of an old-standing dyspepsia. It may be slight at first, generally severe later, and has little tendency to stop, since the eroded arteries are unable to close owing to being surrounded by adhesions. The treatment is as a rule to operate, ligature the blood-vessels, and then perform gastro-enterostomy.

Hour-Glass Stomach.—This condition may be congenital, but very rarely; it is usually acquired, and is one of the complications of ulcer arising from perigastric adhesions, perforation, and the adhesion of an anterior ulcer, or, as already pointed out, cicatrization of a transverse median ulcer.

The stomach is divided into two more or less equal parts by a transverse band; the opening between the two may be very narrow or comparatively large. The symptoms are usually those of a chronic ulcer and dilated stomach. It is found that fluid introduced into the stomach is not all returned, but that there may be a flow of decomposed fluid after the stomach is apparently washed clean. Splashing may also be detected, and gurgling sounds as gas or fluid passes from one cavity to the other.

Treatment.—The usual treatment nowadays for this condition is to perform gastro-enterostomy, uniting the cardiac end of the stomach to the jejunum. Other operations are sometimes undertaken, such

as gastroplasty, dividing the stricture and sewing the organ up transversely; gastro-anastomosis, which consists in making a large opening between the pouches; and a partial gastrostomy, which is necessary when the condition is due to malignant disease.

Dilatation of the Stomach.—This is due to several causes, but usually is the indirect result of ulceration, either by causing obstruction at the pylorus or in the duodenum. It may also be due to malignant disease or the dragging of a movable right kidney, etc., as well as to constitutional causes, such as debility, or the result of a nerve lesion, producing a toxic condition, when the dilatation is acute.

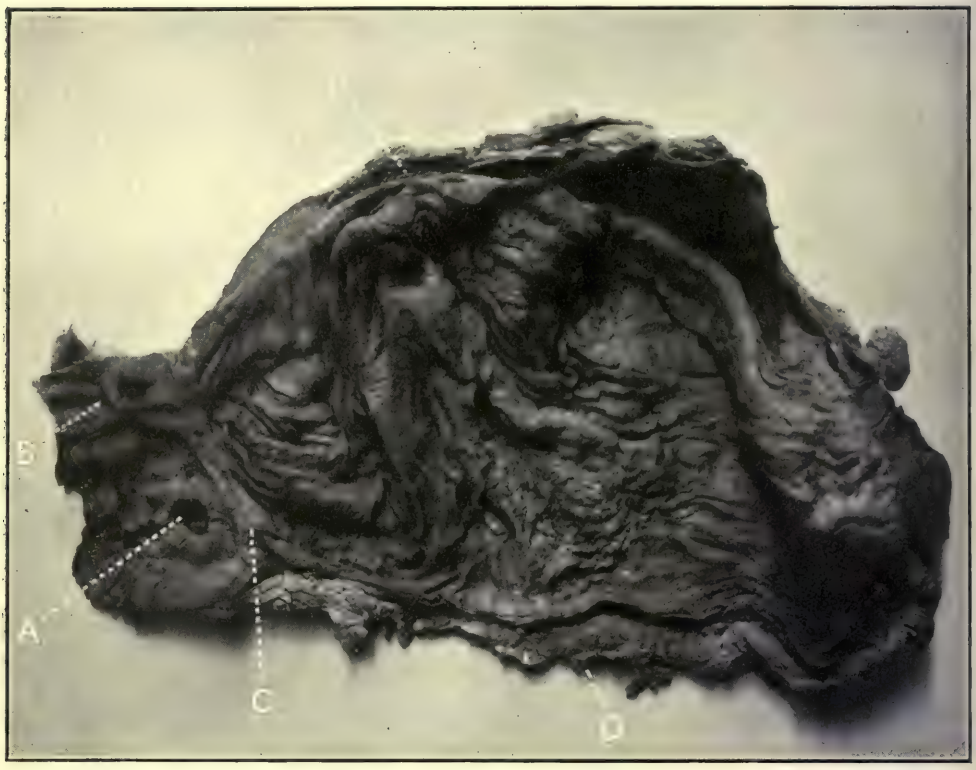
The **Symptoms** are dyspepsia, vomiting at intervals of large amounts of decomposed fluids, in which undigested food, taken some time previously, may be recognized. When the condition is due to ulceration, there is present an excess of free hydrochloric acid; when due to cancer, lactic acid is present and free hydrochloric acid is absent, and sarcinæ are frequently present. There is a dull pain; thirst and constipation are present, with progressive wasting; the temperature is low, and asthenia is present; tetany is observed in some cases. The signs of the condition are an increased area of stomach dulness, and the presence of succussion splash; a visible peristaltic wave is seen when the condition is due to chronic pyloric obstruction.

Treatment.—The diet should consist of small dry meals, with fluid between them. Of drugs, creosote or carbolic acid check decomposition in the stomach contents, while acids or alkalies should be given according to the reaction present. The daily washing out of the stomach with water or mild antiseptics is much more serviceable than drugs, and frequently cures the condition. Of operative procedures, gastro-enterostomy is the best, and should be adopted in all obstinate cases the result of simple obstruction; but it is of little service when the condition arises from lack of tone of the muscle walls.

Perigastric Abscess.—This is usually secondary to gastric ulcer, and results from a subacute rupture. The abscess is generally situated in the subphrenic area, but may be localized in the epigastrium. A fistula is caused when the abscess ruptures through the abdominal wall or into one of the hollow organs in the abdomen. When the external fistula is situated near the cardiac end of the stomach, the escape of its contents is not continuous, and the health of the patient remains good; but when near the pyloric end, the escape is continuous, and the patient's health is undermined by lack of nutrition.

The abscess should be drained, and if the fistula is not very large it will probably heal when the patient is fed by the rectum. If, however, it persists, laparotomy should be performed, the ulcer excised, and the stomach closed. In internal fistula—viz., that between the stomach and a hollow viscus, which is frequently the transverse colon (gastrocolic fistula)—the stools contain undigested food, there is vomiting of fæcal matter, and foul eructations. The treatment of this condition consists in exposing the organs affected, separating them from one another, and closing the apertures by suture.

PLATE LVIII.



DUODENAL ULCER.

A, Perforating ulcer on anterior surface of duodenum; *B*, "kissing ulcer" on posterior surface; *C*, pyloric ring; *D*, *D*, cut edge of lesser curvature of stomach. (Note the position of the ulcers immediately outside the pylorus.)

The specimen was removed from a woman aged thirty, who died about two hours after admission to the Royal Victoria Hospital, Belfast (May, 1909). No operation was undertaken.

(Mr. A. B. Mitchell's photograph of his case.) *From Moynihan's "Duodenal Ulcer."*

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DUODENAL ULCER.

This ulcer occurs more frequently in men than in women. It is often associated with gastric ulcer ; as a separate condition it is much less frequent than the latter. It is often multiple, one ulcer being opposite to another. The situation is usually in the first part of the duodenum. There is no particular age incidence for the ulcer, and children in the first decade are often affected.

Symptoms are largely those of gastric ulcer—namely, pain and vomiting, excess of free hydrochloric acid being also present. There are, however, many cases which do not give rise to any symptoms, and others where the first symptom is hæmorrhage or perforation. The pain is dull and aching in character, and is usually felt to the left of the middle line ; it occurs from three to four hours after food, and is often relieved by the ingestion of food. A. B. Mitchell regards "hunger pain" of a gnawing, aching character, coming on two or three hours after food, and relieved by ingestion of food or drink, as almost pathognomonic of duodenal ulcer, especially when it occurs at night. He states that he has never failed to find a well-defined ulcer when typical night pain, coming on at a definite hour, was complained of, and regards this as a valuable point of distinction from the neurasthenic type. Bleeding is more likely to be fatal, and is not so amenable to medical treatment as in gastric ulcer ; but the symptom of hæmorrhage is not so often recognized, because the blood is frequently passed in the stools, and not noticed. It may, however, also occur in the vomited matter. Occasionally even severe hæmorrhage is not discovered, and the patient may die from this cause. The gastroduodenal and the right gastro-epiploic arteries are most often involved.

The pain associated with affections of the gall-bladder and ducts often simulates the pain of duodenal ulcer, and these may coexist.

The ulcer may be acute or chronic, the former being more liable to result in perforation, the latter being complicated by hæmorrhage and subsequent cicatrization.

Perforation may be mistaken for acute appendicitis on account of the exudation gravitating to the right iliac fossa. The condition is met with frequently, and the results are graver than in the case of gastric ulcer. In subacute and chronic cases subphrenic abscess or a fistula may result.

A cicatricial contraction may give rise to signs and symptoms which may be mistaken for pyloric obstruction ; the condition is treated in much the same way as the latter. The bile and pancreatic ducts may become closed by the inflammatory process, and carcinoma may occur at the site of the ulcer.

Treatment.—Gastro-enterostomy is the routine treatment, and it is not usually necessary to deal specially with the ulcer at the time of operation.

For hæmorrhage it is usual to give morphine and apply an icebag. If severe, when the patient has rallied somewhat from shock, gastro-enterostomy is performed. In this condition, when it can be done, the ulcer is excised, or the affected part of the gut wall is enfolded by means of suture.

When duodenal fistula follows upon perforation, the patient is i able to suffer from starvation ; when this occurs, jejunostomy is per-

formed as a temporary expedient, and later on, when the condition of the tissues of and around the duodenum warrant it, the fistulous opening is closed.

TUMOURS OF THE STOMACH.

Simple Tumours.—Simple stomach tumours are very rare. They are—

Adenoma, which occurs as a polypoid mass having a narrow pedicle ; it may precede malignant disease.

Myomata.—These may be situated inside or outside the organ.

Cysts.—Cysts occur between the coats of the stomach or the layers of the omentum. They are thought to be formed by a budding off of some outgrowth of the stomach. They may give rise to signs of a tumour in the epigastric region. Vomiting may be caused by the cyst blocking the pyloric opening. They have to be diagnosed from other abdominal conditions giving rise to similar symptoms. The cyst should be removed and subjected to microscopical examination in order to determine if malignant disease is present.

Malignant Tumours—Sarcoma.—This is not common, and when present the variety is usually spindle-celled or lympho-sarcoma. The signs of the condition are very similar to those of carcinoma. Gastric dilatation, however, is not so marked, and the tumour is usually larger and may be palpated with greater ease. It occasionally happens that the spindle-celled variety grows as a polypus and can be removed locally.

Carcinoma.—This tumour occurs as a rule at and after middle life. It is more common in men than in women. It may occur at the site of a gastric ulcer. The pylorus or the lesser curvature near the pylorus is the part usually affected.

It is usually seen as a growth surrounding the pylorus, the canal of which is narrowed or obliterated. The new growth ends usually at the duodenum. It extends farther along the lesser than the greater curvature. The wall of the stomach is considerably thickened, and the muscle hypertrophied near the growth. The mucous membrane may be destroyed by ulceration, and the peritoneal covering is usually thick and puckered. It may also occur as a soft fungating mass having an infiltrated base, or as an ulcer with everted edges, or may lead to the production of the so-called **leather-bottle stomach,** in which there is contraction and infiltration of the whole organ.

The most common form of carcinoma of the stomach is the spheroidal-celled variety of the scirrhous type. The next most common is the columnar-celled. Either may undergo colloid degeneration. Occasionally a squamous-celled tumour growing from the œsophagus is met with. Extension of the growth may occur to the lymph glands on the lesser curvature ; to the portal fissure of the liver or around the cœliac axis ; to the peritoneal surface, forming adhesions to the liver, pancreas, colon, or the anterior abdominal wall.

Symptoms.—The patient usually complains of indigestion and pain, which is of a dull character, and is relieved by taking food. There is progressive wasting, anorexia, and very sensitive patches occur in the front of the thorax and the upper part of the abdomen. The tumour is at first movable and small, and is usually situated about the level of the ninth costal cartilage, a little to the right of the middle line. When the body of the stomach is involved, there is an indefinite tumour

in the epigastric region. The vomiting in the case of a pyloric growth is intermittent at first, being only once in every two or three days, but gradually increasing to several times each day. A large quantity of matter is vomited, which is sour, mixed with blood, and of coffee-grounds appearance. When there is general carcinoma with contraction of the stomach, the vomiting occurs usually after each meal. The vomited matter usually contains no free hydrochloric acid, and there is presence of lactic and butyric acids, sarcinæ, and particles of previously ingested food, together with portions of the growth and some blood-cells. The Boas-Oppler bacillus is often present, and was formerly thought to be pathognomonic of the disease, but is not now so regarded, as in many cases it is absent, and it is also present in cases which are not malignant. Dilatation of the stomach is present when the pylorus is involved. When distended, the great curvature may descend below the umbilical level. On palpation there is splashing in the stomach. Auscultation reveals an enlarged gastric area, and the peristaltic wave runs from left to right across the epigastrium. Dysphagia is present when the œsophageal opening is involved. Hæmoglobin is diminished in the blood, and leucocytosis is present. Later on there is progressive wasting, the skin is yellow and loose, and in the abdomen there is a hard mass in the region of the stomach. Ascites is present, and swelling of the legs occurs. Pain of a severe character is referred to the back, and the left supraclavicular glands are often involved.

Diagnosis.—The earlier this is made, the better, as, once the disease is well established, anything like radical treatment becomes impossible. The points to lay stress upon for an early diagnosis are dyspepsia of an insidious type, beginning for the first time in a patient over fifty; marked wasting; diminution or absence of free hydrochloric acid from the stomach; the presence of a tumour; some signs of dilatation of the stomach. The condition is distinguished from that due to chronic ulcer by the history in the latter case of a long-standing dyspepsia; bleeding, when it occurs, being in large quantity and composed of almost pure blood, and free hydrochloric acid being increased, not diminished; while the patient is usually younger. It is not possible to lay down lines of diagnosis from all abdominal conditions which may simulate malignant disease, but it is well to remember that in patients over forty-five, when pain and wasting are not amenable to treatment, malignancy may be present, and an exploratory operation is advisable.

Treatment.—Symptoms can only be relieved by drugs, etc. Radical treatment, which consists of gastro-enterostomy as a preliminary to excision of the growth, should be performed when possible. The contra-indication to radical operation is an extension of the growth to the peritoneum, liver, heart, the glands at the portal fissure, or fixation of the growth to the liver or pancreas.

Gastroptosis.—This is a prolapse of the stomach in which the pyloric end may sink to a much lower level than usual. If the patient be asked to swallow a large amount of water while standing, the stomach stands out markedly, while the lesser curvature and the pylorus may be found to have sunk as low as the level of the umbilicus, while the greater curvature is on a level with the pubes. The condition may also be shown by means of the X rays after some bismuth emulsion has been swallowed.

The **Symptoms** are pain in the epigastric region, increased by standing or exercise. Splashing may be heard. Neurasthenia is often a marked symptom.

The **Treatment** consists in massage and lavage, and the condition may be helped by wearing a supporting bandage. By operation the gastro-hepatic omentum and the gastro-phrenic ligament may be shortened (gastropexy).

Phlegmonous Gastritis.—An acute affection of the stomach wall. Pus forms in the submucous coat. The condition starts suddenly, and is attended with severe pain and tenderness, constant vomiting, and symptoms of septic poisoning. If the condition spreads to the serous coat, symptoms of peritonitis will supervene. The disease is brought about by the entrance of pyogenic organisms through an abrasion in the mucous membrane of the stomach.

Treatment consists in relieving symptoms, and if an accurate diagnosis can be arrived at operative interference may be adopted.

Cardiospasm. — In this condition there is difficulty in swallowing, which is associated with dilatation of the œsophagus. It occurs in neurotic persons, and may be of a painful paroxysmal type, lasting from a few hours to some days. One form is probably alcoholic in origin. It may be chronic, lasting for years, and seriously interfering with health. There is spasmodic pain on swallowing, and signs of dilatation of the œsophagus. The food is regurgitated, and wasting takes place. The reaction of the regurgitated matter is alkaline, distinguishing it from vomited matter. The diagnosis of the condition is made by the fact that fluids can be easily swallowed, bougies pass to-day, but not to-morrow, and that almost all food swallowed is regurgitated.

Treatment.—This consists in stretching the muscle of the cardiac orifice of the stomach by passing bougies.

AFFECTIONS OF THE INTESTINES.

OBSTRUCTION.

This may be **acute** or **chronic,** the chronic sometimes becoming acute.

The acute form is caused by **strangulation** owing to bands; the bowel slipping through apertures, as in hernia ; by **kinking, volvulus, intussusception,** or **obstruction due to a foreign body.**

The chronic form, which is less common than the acute, is caused by **stricture; tumours in the bowel wall; pressure of tumours outside the bowel; and by fæcal accumulation.**

Speaking broadly, men and children are more subject to the acute variety, and women to the chronic.

Stricture will not cause complete obstruction if the contents of the bowel at the place affected be fluid ; thus, strictures of the small intestine to be fatal must be narrower than those of the large. In the small intestine a large percentage of the cases is due to cicatrization following ulcers, hernia, or injury, the remainder being due to

malignant disease. In the large intestine, exclusive of the rectum, the majority of the cases are due to cancer, about 35 per cent. being due to cicatrization. Actual obstruction may be caused by fæcal matter or the production of kinking and volvulus.

When there is no strangulation, the bowel below the obstruction is empty and contracted, except in the case of the lower part of the rectum, which is usually dilated as a result of rectal stricture. Above the obstruction the bowel is dilated and hypertrophied, especially if the case be chronic. The mucous lining is usually ulcerated. These ulcers frequently cause death by peritonitis following perforation, or they may produce fæcal fistulæ. Pouching may be present, and is most common in the large gut; the pouches may become filled with undigested food when situated above the obstruction. Gangrene, if present, usually occurs above the obstruction.

When strangulation is present, the symptoms will probably be of an intense character, which, however, will vary according to its site, tightness, and the amount of gut wall involved. Above the strangulation the bowel is congested and distended with gas and fluid, while below it is empty and of a pale colour. The loop of bowel that is compressed becomes at first congested and œdematous; later on it loses its lustre, and is covered with a sticky exudation, the colour changing from purple to black, and the gut finally becomes gangrenous. A line of ulceration and gangrene may occur in the proximal loop at the line of strangulation. The cause of most of the trouble in strangulation is the blocking of the blood-supply, leading to thrombosis, meteorism, and gangrene.

Acute Obstruction—Symptoms.—Profound shock and prostration are present; the face is drawn and pale, and has an anxious expression; the temperature is subnormal and the body covered with a cold sweat; the pulse is soft and rapid and increasingly weak; respiration is quick and sharp; and there is vomiting, especially at first. The shock of obstruction is sometimes hard to distinguish from that due to other conditions caused by affections of the peritoneum. The extent is dependent on the suddenness of the strangulation, its tightness, and the part of the gut involved, strangulation of the small intestine producing greater shock than that of the large; the age of the patient is also an important factor, as shock is profound in early youth. The initial shock usually lasts about twenty-four hours, unless in very severe cases.

The pain present in obstruction is due to the nipping of the bowel, abnormal peristaltic movement above the obstruction, distension of the bowel, and perhaps to peritonitis; it is sudden in onset, constant in complete obstruction, intermittent in partial. It is usually referred to the umbilicus, and is not reliable as giving an indication as to the position of the obstruction. At first there is little pain on pressure, but local tenderness may appear over the site of the obstruction after the first few days, and is followed by the diffused tenderness of general peritonitis. The pain changes its character, or may diminish in its intensity when perforation, septic poisoning, or peritonitis, sets in, and is increased after food or aperient medicine is taken. If gangrene supervene, pain may disappear altogether.

Vomiting is due to initial shock, and later to obstruction of the gut, peritonitis, or distension. At first the vomited matter is bilious in character, and becomes stercoraceous after a few days; fæcal vomiting may occur, but is rare; the tongue is very dry and foul.

Obstruction is absolute—*i.e.*, neither fæces nor flatus can pass in most cases. This is largely due to paralysis of the bowel. The part below the obstruction may empty itself, but this is not usual.

Diarrhœa of a spurious type is not common in acute obstruction, except in that due to intussusception. Distension of the abdomen in the central part occurs in obstruction of the small bowel, and when the colon is affected it is seen on the flanks. The most extreme distension is met with in volvulus of the sigmoid. It is increased with the onset of peritonitis.

Except in intussusception, it is rare for a tumour to be felt in acute cases.

The urine is diminished, and may be suppressed by shock; indican is present in acute cases, with involvement of the small intestines. The temperature is usually subnormal, rises on the onset of peritonitis, and falls on the occurrence of perforation.

In most cases which end fatally peritonitis occurs, caused by exudation of bacteria through the bowel wall or by perforation. Its onset may be detected by the abdomen becoming rigid in contradistinction to its previous flaccid condition; by the rise of temperature, which is not, however, always constant; and by the pulse, which becomes hard and thin. When due to perforation, there may be the signs of gas and free fluid in the peritoneal cavity. Toxic poisoning may occur with peritonitis or without it, and is evidenced by delirium, very dry and foul tongue, livid complexion, profuse sweating, and a very rapid pulse and weak respiration.

Chronic Obstruction.—The causes of this are as stated above, malignant stricture being the most common of all.

The onset is very insidious, and the symptoms appear gradually, the progress of the condition being intermittent. Attacks of so-called "indigestion" and of general abdominal pain may follow the taking of food; as they become more frequent and increase in severity, and perhaps are accompanied by vomiting, the condition attracts attention. A history is often given of increasing difficulty in making the bowels act even with aperient medicine. There may be the history of an occasional passage of a good deal of mucus mixed with fæcal matter (spurious diarrhœa), which is probably caused by the inflammation set up by the fæcal matter above the obstruction, and is chiefly met with when the site of obstruction is low down in the colon. In most cases, as the bowel becomes distended and thickened above the obstruction the abdomen becomes more prominent. On palpation, peristaltic movements are found to be exaggerated, and the patient complains of pain. If the patient be thin, coils of intestines may stand out, and in the case of the small intestine they are arranged in what has been called the "ladder pattern." If the large intestine be distended, the cæcum, transverse colon, and sigmoid, are the parts which are most readily made out from their shape and situation. If the obstruction is unrelieved, the symptoms increase, the mouth becomes foul, the patient wastes, and cachexia shows itself, death resulting either from exhaustion or some complication, such as peritonitis following perforation.

When the obstruction is in the small bowel, the pain is affected by ingestion of food; aperients may relieve the condition, and vomiting is frequent; the duration of the disease is up to six months. When the large bowel is affected, the indigestion symptoms are often absent; aperients aggravate instead of relieving, and may even cause perfora-

tion, collapse, and death. Vomiting is rare unless the obstruction is absolute. Blood and mucus are passed, and spurious diarrhœa is marked. The length of life in these cases is rather longer than in small-bowel obstruction.

Chronic Obstruction becoming Acute.—In a number of cases, when the gradually narrowing bowel becomes suddenly completely closed acute symptoms show themselves; this blocking may be due to impaction by fæcal matter, or to kinking of the affected portion of gut resulting from sudden change of position or distension with gas, etc. The giving of purgatives on the one hand, or morphia on the other, may also be provocative of acute symptoms. In some cases attention is first directed to a malignant stricture by the beginning of acute obstruction, the previous history having been simply that of indefinite pain and dyspepsia.

Diagnosis of the Position of the Obstruction.—The distinction between a small and large bowel obstruction is not great, and cannot be considered as any definite guide, since the symptoms are more dependent upon the cause of the obstruction than upon its position. As a rule, however, obstruction of the small intestine causes early vomiting which is persistent, and the matter vomited is copious, and becomes stercoraceous at an earlier date than is usual in the case of the large intestine. In obstruction of the large intestine vomiting is later, and when present is intermittent and scanty; shock is not so marked in the large as in the small intestine. The lower down the site of obstruction, the more marked is distension of the abdomen. Some guide may be got as to the position of obstruction by identifying coils of distended intestine, especially in the case of the transverse colon or sigmoid flexure. When the small intestines are affected, they may be recognized by the ladder arrangement already referred to. Peristaltic action clearly seen or felt in the coils of the intestines, does not necessarily mean that the obstruction is situated there, nor is the injection of any measured quantity of fluid by the rectum a reliable test as to position.

Treatment of Obstruction.—Morphia is valuable for relieving pain and for keeping the bowels at rest, thereby allaying vomiting; it also increases the flow of urine, and prevents rapid development of intussusception. On the other hand, it rather obscures the diagnosis and paralyzes the gut; it should therefore, as a rule, not be given until the diagnosis is certain, and then in very small doses. A simple enema should be given early, but not repeated; it has as a rule no effect in the removal of intestinal contents above the obstruction, but it helps to cleanse the bowel below it. The ordinary purgatives should never be given if obstruction is present, as they increase the pain and the vomiting, and may lead to various complications. The patient should be fed by the bowel if obstruction is marked. A drink of warm water may be allowed, as it cannot do much harm to the obstructed portion of the bowel, and by causing vomiting it washes out the stomach, helping thus to prevent fermentation. Actual washing out of the stomach may give relief from vomiting, and is a good routine to follow prior to operation.

Operative Treatment.—Once absolute obstruction is present, operation should be undertaken, since a favourable prognosis largely depends upon the early date at which the operation is performed. Some men prefer to use spinal anæsthesia, and some local, but, granted a skilful anæsthetist, ordinary general anæsthesia is probably prefer-

able, as in his hands the least possible amount of anæsthetic will be made to suffice.

The abdomen is opened in the middle line, except when the obstruction is known to be malignant stricture below the sigmoid or to result from acute appendicitis. The cæcum should first be examined, and if found distended it may be assumed that the large bowel is affected. The pelvis and left iliac fossa may next be examined ; as a rule the large bowel can be examined *in situ*, but the small will have to be drawn up into the operation wound. If the case be *in extremis*, enterostomy in the most available coil of intestine to relieve urgent symptoms and to tide over the crisis is all that can be done. If it is found that the distension is so great that the bowels cannot be properly handled, a fine trocar may be thrust in to allow the gas to escape. When the diseased condition has been localized, it must be treated according to circumstances. If the bowel is gangrenous, it will be found only possible, as a rule, to bring it outside the abdomen and perform enterostomy above the disease. This operation should also be carried out if, after removal of the cause of obstruction, great distension should occur.

If for any reason it is necessary to remove a portion of the bowel, or undertake any other extensive operation in order to deal with the cause of obstruction, it may be done at the time of the first operation, if the patient's strength warrants it. As a rule it is better to do this at a subsequent operation. The primary object in acute obstruction is to give relief; the removal of the cause is, at the moment, of subsidiary importance.

CONDITIONS CAUSING ACUTE OBSTRUCTION.

Internal Strangulation.—The agencies producing this are of various kinds.

It may be due to **bands** resulting from some form of local peritonitis or from tuberculous disease of the intestines. They may form an arch beneath which the gut is caught, or loops in which the gut becomes knotted. **Omental adhesions** may give rise to cords which act in a similar manner. **Meckel's diverticulum** may cause obstruction by binding down or becoming entangled with the intestines. It may also act by producing intussusception or volvulus, and it occasionally causes a stricture at the site of its junction with the gut. What are called **false diverticula**—viz., protrusions of the mucous membrane through the outer wall of the gut, especially when they protrude into the appendices epiploicæ—may cause obstruction by giving rise to bands consequent on inflammation. **Adhesions of normal structures,** as the tip of the appendix to the mesentery, of the ileum, etc., and **apertures in the mesentery or omentum,** the result of congenital defect or of accident, may also be responsible for obstruction by reason of a loop of gut slipping through and becoming strangled.

In strangulation it is usually the small intestine, and generally the lower part of the ileum, which is caught ; the congestion produced by the pressure of the blood in the returning veins, together with distension by gas and a possible twisting of a loop of intestine, give rise to acute obstruction.

Signs and Symptoms.—Strangulation usually occurs in young adults who have had a previous attack of peritonitis, or some kindred ailment

likely to produce adhesions. The onset is sudden, and may be immediately determined by some straining movement; pain is early and severe, and usually continuous. Vomiting is severe, and the vomit copious; it becomes stercoraceous after the fourth day. Collapse is marked. The abdomen is not characteristic; some local dulness or swelling may be caused by the distension above the obstruction. If untreated, the cases usually last about a week, or three days after stercoraceous vomiting begins, death being early, according to the tightness of the strangulation and to the site and length of the bowel involved. Death is due to septic poisoning, collapse, peritonitis with or without perforation. In **treating** these cases, all bands should be divided, after first being ligatured on both sides; diverticula should be completely removed and the resulting stump sutured, and apertures closed after disengaging the bowel.

Internal Herniæ.—When **diaphragmatic,** the condition is usually congenital or traumatic. The stomach, colon, or small intestine, is involved, and enters the thorax through an opening in the diaphragm. The symptoms may be acute or chronic. Diagnosis of the exact condition is almost impossible. **Treatment** consists in closing the aperture into the pleural cavity; it is a very grave and usually unsuccessful operation.

Duodenal Hernia may occur in several ways at the junction of the duodenum and the jejunum, the gut entering one of the fossæ in this region. It usually pushes before it the peritoneal lining, thus forming a sac, the contents of which are as a rule a portion of small intestines; constriction may be produced at the orifice of the sac. The only **Treatment** is by operation to remove the contents from the sac and obliterate its neck. This is difficult on account of the large vessels in front of the neck.

In **Hernia into the Foramen of Winslow** part of the intestine passes through into the small sac of the peritoneum.

Inter-sigmoid Hernia occurs when the bowel passes into the fossa, a funnel-shaped depression between the layers of the pelvic mesocolon.

In **Peri-cæcal Hernia** the bowel passes into one of the pouches which occur at the junction of the ileum and the cæcum. **Treatment** is directed to endeavouring to reduce the hernia through an abdominal wound; it often proves difficult.

External Hernia.—Strangulated hernia is a very common cause of acute obstruction, and it is always wise to exclude it by making an examination of the various hernial openings. It may happen that a patient is unaware of the existence of a hernia until strangulation sets in. A hernia may be present, and yet not be the cause of the obstruction; it is well, therefore, to explore the hernia before opening the abdomen.

Kinking.—This is usually produced by a loop of bowel being turned over a band, the bowel becoming adherent to some neighbouring structure, or volvulus of the loop taking place. The bowel may also be kinked by contraction on a band or diverticulum. The effect of adhesions following inflamed or strangulated hernia may be to produce an acute angle or double acute angle in a loop of bowel. Symptoms

of obstruction may not come on for some time after the hernia. Contraction of post-inflammatory adhesions may compress the gut ; this is common in the hepatic flexure of the colon following inflammatory affections of the gall-bladder. Several coils of the small intestines may become matted together as a result of local peritonitis, and subacute obstruction result. When the large intestines are affected in this way, it usually follows an extreme degree of constipation and ulceration, and gives rise to chronic obstruction.

Symptoms.—This condition is rare, and the symptoms vary so as to simulate any form of obstruction. If the kinking is sudden, there will be acute obstruction, but it is usually very gradual, and may be intermittent. Accurate diagnosis is very difficult until the condition is seen.

On opening the abdomen, it may be possible to separate the adhesions if they are not too extensive ; but where there is great matting together of bowel and neighbouring structures it will be necessary to establish an anastomosis between the bowel above and below the obstruction. Cases, especially if tuberculous in origin, usually do well.

Volvulus.—This condition is caused by twisting of a loop of bowel, either by rotation around its own mesenteric axis or by falling over the pedicle of another loop of gut. The former is the more usual. The **sigmoid flexure** is the part most often affected, on account of the length of its mesentery ; next in order is the **small intestine,** and then the **ascending colon** or the **cæcum.**

In sigmoid volvulus the loop and its mesentery are usually abnormally long, and the attachment of the mesentery narrow. Sometimes the peritoneal covering of the mesosigmoid is thickened and much contracted, this making the two ends of the loop unusually close together. The usual predisposing cause of the condition is chronic constipation, while the actual volvulus is brought about by irregular and increased peristaltic action, by changes in the position of the body, and by movements of neighbouring coils of intestines. The amount of rotation varies from a half to a whole circle, but it may happen that the bowel is twisted round several times upon its mesenteric axis. The lumen at the ends of the involved loop is occluded by their pressure one on the other, while the portion of bowel included in the volvulus becomes filled with gas and engorged with blood, and may be so distended as to reach to the umbilicus or higher; it usually lies in front of the small intestines. Local peritonitis develops early as a rule, and spreads until it becomes general. Should the patient live and the condition be unrelieved by operation, gangrene of the involved bowel will take place.

The volvulus sometimes affects a loop of small gut having an abnormally long mesentery ; a gall-stone in the lumen of the bowel, or strangulation by a band, may cause the twist, which usually amounts to one complete turn or more.

Colic and cæcal volvulus is the most rare, but is met with when there is a long mesentery. The cæcum may be found in any part of the abdomen, but usually in the left hypochondrium.

Symptoms.—The sigmoid volvulus is most common in the male sex between the ages of forty and sixty. The condition usually begins suddenly with severe pain, which is liable to exacerbations, and is referred to the umbilicus, or occasionally to the left iliac fossa ; vomiting is not usual ; collapse is not marked. The abdomen is dis-

PLATE LIX.

Ileo-Cæcal Intussusception.

(Museum, Queen's University of Belfast.)

[To face page 535.

tended and rigid from the distension or peritonitis. Tenderness is present over the affected gut, and finally over the entire abdomen. A tumour may be made out.

Treatment.—This consists in opening the abdomen and seeking for the twisted bowel ; when discovered, it should be brought as far as possible into the wound. If found much distended, it should be opened and emptied ; and if the walls have not suffered very much, the twist having been undone, the bowel is returned to the abdomen and the wound closed. In some cases the walls of the bowel are too far gone to admit of this, and in others it is not possible to undo the twist; in these cases the bowel must be resected. This may be done in two stages : the bowel is drawn out of the wound, and an artificial anus made above the site of the twist ; resection of the loop is carried out at a later period.

Volvulus sometimes recurs. In order to prevent this, the meso-colon may be sewn to the parietal peritoneum ; but if an artificial anus is first made, this causes adhesions, which will prevent recurrence.

Intussusception.—This is a prolapse of one part of the bowel into that immediately adjoining it, and is responsible for a considerable number of cases of obstruction. Its exact etiology is not known, but it is assumed that it occurs as a result of disturbance of normal peristaltic movement; a portion of intestine being in a condition of spasm, the part below is drawn over it by contraction of the longitudinal muscular fibres. The condition usually follows some disturbance of the intestinal track, especially in those who have particularly irritable intestines.

Construction of Intussusception.—Three layers of bowel are arranged one inside the other ; the peritoneum is in contact with the peritoneum, mucous membrane with mucous membrane.

The outer layer is called the **sheath,** or **intussuscipiens.** The middle is the **returning layer,** which has its coats reversed—mucous membrane outside, peritoneum inside. The inner layer is called the **entering layer,** and the inner and middle layers taken together are called the **intussusceptum** ; the peritoneal coats of these two layers usually adhere, as they are in contact with one another. The **neck** is the junction of the sheath and the returning layer where they grasp the inner layer, and the **apex** is the junction of the inner and middle layers.

The intussusception may be **enteric** and composed entirely of small intestine ; the jejunum is more usually affected than the ileum.

It may be **colic,** composed of large intestine, and is commonly met with in the region of the sigmoid flexure; these forms are usually short.

It may be **ileo-cæcal,** which is the most common, especially in children, and is of large size. In this the ileo-cæcal valve, which forms the apex, goes down the colon, and pulls with it the cæcum and the ileum.

It may also be **ileo-colic,** in which the ileum is prolapsed through the ileo-cæcal valve, which remains in its place.

Very rare forms of intussusception are—

1. That of the small gut, sometimes met with in the dying ; it may occur during rigor mortis.
2. A retrograde intussusception of the colon.
3. Double, usually caused by one intussusception being bodily prolapsed into the bowel below.
4. Intussusception of the ileum. The apex is formed by the ileum reaching the ileo-cæcal valve, which it passes through or pushes in front of it.

Mode of Increase.—This usually takes place in the same way in all varieties—viz., at the expense of the sheath. The apex remains the same throughout, which is due to the fact that the inner and middle layers have their peritoneal coats in apposition, and these adhere together, while the outer and middle coats have mucous surfaces apposed, and these readily glide upon one another.

Pathology.—The mesentery becomes drawn into the intussusceptum between the middle and inner layers, is stretched by the traction of the increasing intussusception, constricted at the neck, and its tissues become swollen by exudation. The bowel above the intussusception is inflamed and dilated, and occasionally ulcerated. The sheath is not much altered when the case is acute, but in chronic ones local peritonitis is set up, or it may become ulcerated. The intussusceptum becomes curved owing to the traction of the mesentery, its œdematous apex being directed against the wall of the sheath; inflammation of the mucous membrane occurs, which may give rise to shreds of mucus and blood in the stools. Gangrene often occurs in acute cases, and is marked at the neck; if it occur in chronic cases, it is most marked at the apex. Separation of the intussusceptum may take place, and it may be passed as a double tube, varying in length from some inches to two or three feet. Occasionally the intussusceptum is passed as one layer, or even piecemeal.

Obstruction is produced by dragging of the mesentery, which causes the apical opening to be turned against the sheath, or by kinks in the intussusceptum. It is also caused by narrowing of the lumen of the gut by pressure or by the blocking of the lumen by fæcal matter. Strangulation usually results from compression of the vessel of the mesentery by the tissues at the neck, or by swelling of the layers of the intussusceptum, and also from traction or torsion. It may be found impossible to reduce the intussusception owing to adhesions between the coats, usually in chronic cases, or owing to swelling and twisting of the intussusceptum.

Etiology.—The condition usually occurs in young males. Chronic cases are met with in later life. The predisposing causes are various, such as irritative conditions of the bowel, new growths, invagination of Meckel's diverticulum or of the appendix. The exciting cause is irregular peristaltic action.

Signs and Symptoms.—The onset is usually sudden, pain occurs early, is very severe at first, and gradually becomes less. It is intermittent in character, the paroxysms coming on regularly, and when a tumour appears the pain is localized in that region. Vomiting is common at the onset, but becomes irregular and inconstant, being most marked in the enteric forms. It may afford some relief to the condition. There is at first diarrhœa; constipation may follow later; blood and mucus are usually passed in the stools, especially in children. Tenesmus is a prominent symptom, and is most marked when the lesion is near the anus. Shock and diminution of urine are present, but not marked. There is late rigidity of the abdomen, with tenderness over a local area, which may indicate the position of the intussusception. The tumour is felt in about half the cases, most frequently being detected in the ileo-cæcal and the colic varieties; it is most distinct in children, and occurs as a sausage-shaped, curved swelling, which becomes hard during the occurrence of pain. A mass may sometimes be felt *per rectum*, or may even protrude through the anus. The severity of the cases is determined by the

site of the lesion and the youth of the patient. The higher up it is the more acute, and the younger the patient the more severe. Acute cases are often rapidly fatal, subacute less often so, and chronic cases may last for a month or more.

Spontaneous recovery occasionally occurs by natural reduction or spontaneous elimination of the intussusceptum ; the latter occurs most frequently in adults.

Chronic Intussusception is usually of the ileo-cæcal variety, and occurs in adults. It may last for a varying period ; the course of the disease is irregular, and is marked by vomiting, pain, and diarrhœa. There is usually visible peristalsis, and a well-marked abdominal tumour may be felt in many cases.

Treatment.—Morphia is valuable to combat shock, relieve pain, and prevent the increase of the invagination. An enema consisting of hot normal saline is passed into the rectum under anæsthesia. If this does not succeed in reducing the condition, operation should be undertaken.

Operative procedure consists in making a median incision, and bringing the tumour into the wound. Its apex is then pressed in an ascending direction through the sheath (it is dangerous to pull on the entering layer at the neck) ; the great difficulty is the final reduction of the apex, owing to the œdema that is present. When it is found to be irreducible, Barker has recommended, if the sheath be healthy, that a little more intussusceptum should be tucked into it and the two sewn together ; a longitudinal opening is then made in the sheath and the intussusceptum withdrawn, cut off, and the two layers sewn together in the stump. Total resection of the intussusceptum is indicated when the sheath is gangrenous.

Obstruction from Foreign Bodies.—The most common foreign body to cause obstruction is a **gall-stone,** which usually finds its way into the duodenum by ulceration of the wall of the gall-bladder. If the stone is not large, the obstruction generally occurs at the lower part of the ileum, when it also sets up spasmodic contraction of the muscular coat of the bowel ; a comparatively small stone may cause obstruction in this position and under these circumstances. If the stone is larger, the obstruction occurs higher up in the jejunum.

Obstruction from this cause usually takes place in women who are over fifty years of age, who have suffered from attacks of biliary colic, or give a history of the passage of gall-stones by the bowel. The onset is usually sudden, and the pain severe but intermittent ; vomiting is an early symptom, and is usually continuous, the vomit being large in amount and stercoraceous in character. When the attack is acute, constipation and collapse are present. While nearly all cases are acute, subacute or chronic cases sometimes occur. Sometimes, after the onset of an acute attack, some relief may be obtained by the stone passing through the ileo-cæcal valve, and it may eventually be passed through the anus ; or there may be several attacks, subacute in character, at varying intervals, while occasionally the case may present the symptoms of chronic obstruction due to other causes.

Other foreign bodies which block the intestine are **enteroliths** ; they may be phosphatic in origin, derived from catarrhal secretions, or concretions derived from insoluble drugs, as magnesia, bismuth, or salol. Other enteroliths have been described, but are of infrequent occurrence. Obstruction arising from this source is not usually complete ; when so, it is usually in the lower ileum. The case is generally chronic.

Another cause of foreign bodies in the intestines is the swallowing of certain substances which are not capable of digestion ; the presence of tooth-plates is fairly frequent, and all sorts of objects, such as pins, nails, and débris, are found from time to time, swallowed either by design, accident, or as the result of madness.

Treatment.—It is not easy to diagnose the seat of the obstruction, nor yet its cause, until the abdomen is opened. Laparotomy should be performed, and the bowel examined in order to locate the obstruction. When found, the loop of intestine containing the foreign body should be brought outside the wound, and, after being surrounded by gauze, opened in a transverse direction, the obstruction removed, and the incision closed by two layers of sutures. If there is great distension, which does not often occur, it is well to empty the bowel through the artificial opening, and occasionally it is necessary to resect part of the bowel, which may have been damaged.

CONDITIONS CAUSING CHRONIC OBSTRUCTION.

Stricture of the Intestine—Cicatricial Strictures.—These usually result from the healing of an ulcer, and may follow duodenal, tuberculous, typhoid, syphilitic, or dysenteric ulcers.

A **duodenal ulcer** seldom causes marked stricture ; when it does, the condition frequently gives rise to the symptoms of a distended stomach.

The most common form of stricture is that following **tuberculous ulceration** ; it is often multiple, and most frequently situated in the lower part of the ileum or near the ileo-cæcal valve.

Typhoid ulcer seldom causes stricture.

When arising from **syphilitic ulcer,** stricture is usually met with in the rectum or near the ileo-cæcal valve, but it is rare.

Dysenteric ulcers may give rise to stricture in the rectum, sigmoid flexure, or in the colon.

Ulceration following **strangulated hernia**, and leading to stricture, usually affects the ileum ; the symptoms may not appear for some considerable time after the occurrence of the strangulation.

Contraction is often seen round **diverticula** which have been the site of chronic inflammation ; it is most common in the lower part of the colon.

Traumatic Stricture may result from surgical operation ; from a blow on the abdomen which has partly lacerated the gut (this form is associated with adhesions) ; or as a result of foreign bodies producing ulceration by their contact with the surface of the mucous membrane.

Malignant Stricture.—Cylindrical-celled carcinoma is usually the form met with, and it may lead to obstruction in different ways ; thus, it may produce a band round the gut, a mass of fungating tissue which fills up the lumen, or predispose to kinking, and occasionally to intussusception.

There is great contraction of the growth, which fungates towards the lumen of the bowel. Ulceration takes place near the growth, and colloid degeneration may occur in the growth. There may be adhesions between the growth and the surrounding tissues, or they may be infected by it, but not so early as in malignant disease in other situations. Secondary growths may take place by metastasis, especially in the liver, lungs, and glands. The commonest situation for malignant stricture is the sigmoid flexure.

Congenital Stricture. — This is uncommon. When present, it is usually situated in the ileum a short distance from the ileo-cæcal valve, and it is thought that in this situation it may be due to an over-obliteration of the vitelline duct. Occasionally the duodenum or jejunum is the site of a congenital stricture. The common forms are due to the narrowing of the gut till it represents more a cord than a tube, or to a membranous diaphragm with a central opening occurring in the lumen. If the case is marked, there are usually symptoms of obstruction of the pylorus when the stricture is in the duodenum, and of intestinal obstruction when in other situations ; if the condition is not an exaggerated one, it may persist through life, but in severe cases death usually occurs shortly after birth.

Treatment of Stricture.—This will depend largely upon the cause of the stricture. If non-malignant and the stenosis is not marked, the case may be met by dividing the stricture and suturing the bowel at right angles ; if the condition is marked, the portion of bowel may have to be resected. When due to malignant disease, and there is obstruction, relief should be given by opening the bowel above the block. When the cæcum is found distended, it is probable that the stricture will be below this, and the transverse colon should be examined, and, if distended, brought into the wound and an artificial anus made. After the urgency of the case is diminished, the removal of the malignant disease must be considered upon the merits of each individual case. Where there is not any obstruction, removal of the affected area should be proceeded with at once, and gives a reasonably good prospect for a radical cure; or the operation may be done in stages : first, bringing the affected bowel outside the wound ; secondly, removing it and inserting a Paul's tube in each end of the healthy bowel ; and, thirdly, after seven to ten days the ends of the bowel are stitched together.

Tumours of the Intestines—Sarcoma.—This is rare; when present, it is situated in the lower ileum. It assumes the form of an infiltration of the coats, converting the bowel into an inflexible tube, and leading frequently to narrowing of the lumen; it produces similar symptoms to other strictures. The development of the disease is rapid ; but when the bowel is not encroached upon, it usually goes on without giving rise to any symptoms until the formation of an abdominal tumour. Treatment is similar to that for carcinoma.

Other Tumours.—These are very rare, and seldom give rise to symptoms of obstruction. They may be adenoma, or fibroma, giving rise to polypi; lipoma is sometimes met with, and occasionally cystic conditions of congenital origin. They are found frequently in the rectum, and are usually multiple, giving rise to few symptoms, unless they grow to a considerable extent and produce obstruction, when the signs are similar to those from other sources. Occasionally a polypus with a long pedicle may protrude at the anus, or the pedicle may separate and the tumour pass away in the motions. Lymphadenoma and lympho-sarcoma are met with as submucous tumours.

Obstruction by Pressure of Tumours from Without.—These are of various origins, and the following are met with : **Large retroverted uterus,** especially when fibroids or pregnancy are present ; **extra-uterine gestation ; cellulitis of the pelvis ; cancer of the uterus ; tumours of the ovaries; tumours,** especially **cancer, of the bladder;** and **enlarged prostate.** Various other conditions associated with the

mesentery, kidney, pancreas, spleen, and liver, may occasionally produce pressure and obstruction.

The rectum and colon are most often affected. The pressure from without the bowel may give rise to all varieties of symptoms ; thus, the condition may be acute, subacute, or chronic. The treatment depends upon the condition causing obstruction.

Fæcal Accumulation.—Accumulation of fæces is due to want of normal expulsive power, arising from general debility or some special nerve condition. An inhibition of the bowel is sometimes found associated with hæmorrhoids, fissure, ulcer, or some pain in the pelvis caused by an inflammatory condition, or by carelessness as to diet and habits. It may also be caused by dilatation and prolapse of part of the large bowel or some other abnormal anatomical condition, or by Hirschsprung's disease.

The accumulated fæces may take the form of a hard, stony mass without moisture, or a more ordinary condition may be present. The mass is often covered by threads of mucus. The colon becomes dilated and altered in shape, and the walls may be thickened ; while ulceration may take place in them, leading to perforation and peritonitis.

Symptoms.—The condition is more common in women than in men. Constipation is habitual, but there may be attacks of simulated diarrhœa. The appetite is bad, the breath offensive, the tongue extremely dirty, and general symptoms of dyspepsia with flatulence of unpleasant odour are present. Headache, dizziness, languor, and general debility, are complained of. The skin becomes dark and greasy, and the eyes are dull, and sometimes the conjunctivæ are discoloured. The temperature rises, and there may be marked abdominal distension, giving rise to breathlessness and palpitation. Pressure may produce various symptoms, such as sciatica and œdema of the legs. Obstruction may take place, with pain and vomiting, and may prove fatal. A tumour can usually be felt in the large intestine. The most common situation is the cæcum or sigmoid, which is some times doughy and often tender, owing to ulceration.

Treatment.—The case can usually be cured by careful treatment. Saline aperients are valuable, but strong cathartic drugs should not be used. The bowel should be washed out daily with soap and water ; olive-oil enemata, left in for twelve hours, should be employed. Meantime exercise and massage should be carried out. When these measures are not effective, the hard mass may be broken up under anæsthesia. Arbuthnot Lane has advocated operative treatment in the form of ileo-sigmoidostomy for inveterate chronic constipation.

OTHER AFFECTIONS OF THE INTESTINES.

Tuberculosis.—Tubercle may attack the intestines as a widespread disease met with in conjunction with pulmonary infection, but as an affection of the intestine it is usually met with in the region of the ileo-cæcal valve (ileo-cæcal tuberculosis). Obstruction may occur from stenosis, and occasionally a tumour may be felt in the right iliac fossa. Stricture resulting from tubercle is usually met with as a sequel of a tuberculous ulcer, and there may be a series of strictures over the bowel, having between them considerable dilata

tions. Adhesions may take place between the loops of the bowel and the peritoneum ; that investing the gut has usually miliary nodules scattered over it, and the neighbouring glands are at times found enlarged.

Symptoms.—There are the signs of a gradually increasing but incomplete obstruction—viz., recurrent attacks of pain, visible peristalsis, gurgling, and distension of the abdomen, which subsides between the attacks, when one or more tumour-like swellings may be felt through the abdominal wall. The condition is distinguished by the history of the presence of other forms of tubercle and the detection of the bacillus. It is, however, sometimes difficult to make a complete diagnosis before opening the abdomen. To relieve the constriction the affected portion of the bowel may be resected, or an anastomosis of the intestine carried out.

Tubercle may cause many types of disease. The **hypertrophic** is usually limited to the ileo-cæcal region, but may extend some distance in either direction along the ascending colon or the ileum ; there is great thickening of the wall of the intestine, and occasionally adhesions to neighbouring coils of the small intestine and enlargement of the glands of the mesentery. This type of the disease is met with at all ages, but is most common between twenty and forty. There is usually a history of failing health, pain, and alternating constipation and diarrhœa, and there may be blood and mucus in the stools. Vomiting, when present, may be of a persistent type. Should the lumen of the bowel be narrowed, symptoms of obstruction will show themselves.

The tumour is found on the right side in the iliac fossa or the flank. It is usually firm and of cylindrical shape. There is diminished resonance over it, and it is at first freely movable, but may become fixed later by adhesions. The part of the bowel above the disease is dilated, and peristalsis may be noted if the patient is thin. Abscess formation takes place, and when the pus finds its way to the surface a sinus or fæcal fistula may result. The condition is usually chronic, and may go on for years without causing any very marked obstruction, unless the lumen of the bowel becomes very much narrowed.

The infection may spread to the peritoneum directly, or may be carried through the blood-stream to other organs. It is, however, often difficult to distinguish the condition from that due to other causes, and when the abdomen is opened the condition may closely resemble cancer. Resection of the affected part should be carried out where possible; if not found expedient, anastomosis is made between the ileum and the colon.

Embolism and Thrombosis.—The arteries and veins of the mesentery may become blocked ; this may lead to serious trouble if a main trunk becomes obstructed, especially if it be the superior mesenteric artery. The changes produced are those of a hæmorrhagic infarction, which may lead on to gangrene of the bowel.

The **Symptoms** are not always distinguishable from those of an ordinary obstruction of the bowel, such as that due to intussusception and internal strangulation, but may be distinguished in that the clearance out of the contents of the bowel affords little or no relief. It may be possible to detect a tumour, while there is sudden intense pain, simulating violent colic. Frequent vomiting is usually present ; the pulse is rapid and thin, and there is occasionally a good deal of

bleeding from the bowel ; distension of the abdomen is also usually present. The prognosis is not good. On opening the abdomen blood-stained fluid is found, and the small intestine in varying lengths is seen to be dark-coloured, swollen, and hard, the bowel beneath the lesion being contracted and empty. Removal of the affected portion of bowel is the only course to adopt with any hope of saving life, but this procedure may be contra-indicated by the condition of the patient.

Actinomycosis.—This disease when affecting the intestines is of a serious nature, but is not very common. It usually arises from infection through the mucous membrane of the gut, and spreads thence to the peritoneum. There is infiltration of the coats of the infected bowel, and adhesions take place to neighbouring tissues. This causes a tumour, which is badly defined, diffuse, and usually fixed, commonly in the right iliac fossa. An abscess frequently forms, and a sinus is occasioned, which may be very persistent. The fungus of the disease may be discovered either in the pus or the granulation tissue lining the sinus. The treatment comprises the opening up of any sinuses that may exist, removal of the diseased tissue, and giving large doses of the iodides internally.

Enterospasm.—In certain cases there is a spasmodic contraction of the muscular coat of the gut, which leads to a certain amount of obstruction of its lumen. It is due to a functional neurosis, and may be met with in women subsequent to operation involving the pelvic contents. The small and large bowel are both affected, distension with gas takes place, and there may be complete obstruction.

Treatment.—Opium and belladonna may be administered in fairly large doses by the rectum ; if this fails to bring about satisfactory results, the abdomen should be opened and enterostomy performed in the distended bowel above the site of contraction.

Enteroptosis.—This is a displacement downwards of the stomach and transverse colon, and usually of one or both kidneys, giving rise to grave digestive disturbance and neurasthenia. The transverse colon may descend as far as the level of the symphysis pubis, and the stomach to that of the umbilicus. In men the condition is occasioned by poor health, leading to muscular debility; in women it may follow loss of tone in the abdominal wall, owing to compression of the waist and the weight of the clothes forcing the viscera down; or adhesions following pelvic peritonitis may cause the condition by traction. After all, this is but saying that we know little of its causation, since these conditions are found in innumerable cases without producing a like effect.

The **Symptoms** may be severe, out of all proportion to the displacement. On the other hand, grave displacement may give rise to no other symptom than neurasthenia ; the patient usually complains of dragging pain in the abdomen and loins, which becomes worse on standing and is relieved on lying down. The term **splanchnoptosis** is sometimes used to indicate the downward displacement of all organs of the abdomen, " enteroptosis " being retained for those in which the intestines alone are involved.

Special symptoms will be observed according to the organ which is displaced.

Diagnosis may be made by examination of the abdomen, the patient being placed in various positions to ascertain the relative position of

the organs. Displacement of the stomach and intestines may be shown by means of the X rays after introducing an emulsion of bismuth.

Treatment.—This should be directed towards improving the general condition, at the same time removing any factors which may be part of the causation ; the stomach and bowels should be regulated, and the muscular tone of the walls of the abdomen improved by means of massage and certain exercises. Various forms of belts and corsets may be applied while the patient is in the Trendelenburg position. It may be necessary in some cases to resort to operation, which is carried out according to the organ that is dislodged and the condition present. If neurasthenia is marked, it may prove a contra-indication to operation, since frequently this condition prevails even after an operation has remedied the displacement.

Affections of the Appendices Epiploicæ.—They may be twisted, in which case the pedicle becomes tight and gives rise to symptoms of recurrent colic ; separation of an appendix epiploica may result, and give rise to a small fatty tumour lying free in the peritoneal cavity ; or inflammation may occur, giving rise to symptoms of subacute peritonitis.

Obstruction may be caused by an inflamed adherent appendix epiploica forming a band, which causes strangulation of a loop of small intestine.

Long appendices form occasionally the contents of a hernial sac, and if strangulation should occur, gangrene of the appendices may take place. The most common hernia in which to find appendices epiploicæ is a left femoral one in the female sex.

AFFECTIONS OF THE COLON.

Colitis.—Various forms of inflammation, some of them leading on to ulceration, may affect the colon, excluding the dysenteric ulcer, already referred to.

Symptoms.—There is diarrhœa alternating with constipation and accompanied by severe pain ; the matter passed by the bowel contains mucus, pus, or blood, and in some cases membranous casts. If the condition is sufficiently low down, the mucous membrane may be observed through the sigmoidoscope. The patient wastes. Nervous conditions are frequently associated with colitis, and are of the neurasthenic type.

Treatment.—Various medicines may be tried for the local condition, and tonics administered for the constitutional. If these fail, good results frequently follow irrigation of the bowel, carried out through an opening in the cæcum or the ileum, or through the rectum. The advantage of the former route is that the opening can be used as an artificial anus, and so give rest to the affected part. Weir of New York recommended that the irrigation might be carried out through the appendix (**appendicostomy**) after it has been fixed with sutures to the wound and the tip amputated. The method is to pass a soft catheter through the appendix, and retain it in position while the irrigation is being carried out. Normal saline or solution of nitrate of silver (1 in 2,000) is usually employed for the purpose of irrigation.

The result of ulceration may be to produce contraction of the bowel, when surgical interference may be called for.

Chronic Inflammation of the Colon.—This condition is not common. When present, it is usually met with in the sigmoid or in the rectum. On examining the bowel, the impression is given of a solid cylindrical tumour, which may be mistaken for cancer. The peritoneum is usually thickened, rough, and opaque; the lumen of the bowel is lessened to a considerable extent. The changes seen are particularly present in the submucous coat, which is the site of a formation of fibrous tissue that, by its contraction, forces the mucous membrane into the lumen of the intestine as a polypoid protuberance simulating adenoma or papilloma. Between the folds of the projecting mucous membrane there are recesses which are known as **false diverticula.** Ulceration may take place in these and spread to the other coats of the bowel, sometimes producing perforation. There is usually a layer of fat beneath the serous coat, but the muscular coat is not much altered.

Symptoms.—Alternative diarrhœa and constipation, with blood-stained motions, accompanied by abdominal pain and progressive debility. If the rectum be involved, the narrowing of the bowel may be detected *per anum*. If the sigmoid be affected, a tumour of a sausage-like shape is felt below and to the left side of the umbilicus. This is sometimes mistaken for an intussusception.

Treatment of a palliative nature may be carried out, but is not of very much avail, unless for temporary relief of symptoms. The radical cure is to remove the affected portion of bowel.

Diverticula (Diverticulitis, Sigmoiditis, Peri-Sigmoiditis).—False diverticulum has already been referred to as accompanying chronic inflammation. Other forms exist where there are between the folds of the mucous membrane much deeper recesses, in which infective changes frequently take place. This infection may give rise to a local abscess, or may produce general peritonitis.

The **Symptoms** usually met with are those of acute inflammation and suppuration seated in the left iliac fossa. It generally occurs in middle or elderly life; the attack is sudden, and may simulate peritonitis of the left lower part of the abdomen. Resolution may take place or a swelling may persist, which gradually becomes soft and forms an abscess. This may point externally or burst into some hollow organ or the peritoneal cavity. Symptoms of obstruction of the bowel may arise owing to this condition.

Treatment.—For the localized abscess the treatment will be the ordinary one of opening the abscess and treating any pathological condition of the bowel which may be present. When obstruction occurs, an artificial anus is formed, and subsequently the colon is resected.

Hirschsprung's Disease.—An idiopathic dilatation of the colon, probably predisposed to by some congenital defect. Great constipation is caused by dilatation of the colon without any disease of the walls being discoverable. Idiopathic dilatation is a rare condition which is characterized by enlargement of the colon and distension of the abdomen. The affected parts may attain great size, filling the whole cavity of the abdomen; it does not seem very certain whether at the first the dilatation causes constipation, or constipation causes the dilatation. The walls are found thickened, especially the muscular coat, and the gut contains large quantities of odourless fæcal matter;

PLATE LX.

HIRSCHSPRUNG'S DISEASE.

Congenital dilatation of colon with hardened mass of fæces found in it.

(Museum, Queen's University of Belfast.)

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PLATE LXI.

HIRSCHSPRUNG'S DISEASE.

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the mucous membrane is found vascular, and sometimes ulcerated. The pelvic colon is the part most usually involved about the junction of the sigmoid and rectum. There is no narrowing of the lumen of the gut, but there would seem to be some valvular obstruction, at least in some cases, evidenced by the fact that fluids will pass upwards, but not downwards.

Symptoms.—These usually develop during early life; males are more affected than females, especially when the patients are very young. The child appears healthy in other respects; the onset of constipation is gradual, through the bowels being moved less and less frequently. Some relief may be obtained by the use of enemata and massage, but the condition usually progresses, until weeks may elapse without any passage of fæces, although flatus escapes; peristalsis is often observed, and the contraction of the bowel is attended with pain. If untreated, complete obstruction usually occurs, with its resultant symptoms.

When adults are affected, the onset and progress of the disease is very gradual, beginning with obstinate constipation, distension, colic, and some threatening of obstruction. Long periods may elapse between the attacks; the distended colon, especially if the descending and the sigmoid portions are affected, can usually be felt as a large tumour filling up the left side of the abdominal cavity; and the contained matter may be made to pit on pressure.

As a rule, when adults are affected, the cæcum and the ascending and transverse colon are dilated rather than the pelvic colon, which is the part involved in the true congenital or idiopathic variety. In addition, females rather than males are affected, and constipation does not date from early years. It would seem to be very unlikely that these cases in adults are due to a congenital defect, and that middle life is reached, as it usually is, before symptoms manifest themselves.

Treatment.—In children, enemata, especially one of olive-oil at night, left in, and followed by a turpentine one in the morning, act well, and will relieve the distension. Ordinary purgatives do more harm than good. Massage should be carried out, and a diet of milk and eggs adopted.

In adults the above measures, together with exercises and massage, are adopted. The diet should be one leaving little residuum, and consisting largely of milk, fish, eggs, and mealy foods.

As a rule such measures are only of service in mild cases.

Operative Procedure.—Dilatation of the rectum will often release an enormous amount of flatus and temporarily relieve the symptoms.

It has been suggested that in certain cases it is sufficient to make an incision and empty the colon, afterwards trusting to dieting, massage, and the use of enemata, to prevent a return of the symptoms. Others advise appendicostomy, in which the appendix is sutured in the parietes, its extremity removed, and the colon irrigated through the cut end. In pronounced cases the best method is to form an artificial anus as a preliminary step, and subsequently to resect the affected portion and unite the bowel above and below; or to make an anastomosis between the ileum and the pelvic colon. In some cases it may be found of advantage to resect the affected bowel at the initial operation.

The illustrations given show well the appearance of a child suffering from congenital dilatation of the colon. From infancy there had been in this case gradually increasing distension of the intestines and obstinate constipation, which increased till finally nothing but flatus

passed. On opening the abdomen, Mr. Campbell found the pelvic colon greatly increased in length ; at one point a hard mass was felt ; above this the gut was much dilated and hypertrophied, and below it was contracted and thin. The affected bowel, which corresponded with the sigmoid flexure, was resected, and an artificial anus established. The clamps were left on outside the abdominal wound for forty-eight hours ; they were then removed, and at the end of three days the divided ends of the gut were sutured without again opening the abdomen. The hard mass was found to be formed of fæces, which almost blocked the lumen of the gut ; no organic stricture or congenital defect was found. In Mr. Campbell's opinion, the sigmoid was so long in this case that it toppled over and gave rise to the blocking with fæces.

Carcinoma of the Colon.—Carcinoma causing stricture has already been referred to. Of all parts of the bowels affected, nearly half the cases occur in the colon, more than half in the rectum, and only about 5 per cent. occur in the small intestine.

Carcinoma of the colon is most usual between forty and fifty, but is met with at an earlier age.

Pathology.—The columnar-cell variety is practically always present. There is marked thickening of the muscular coats above the growth and at its site ; the muscular layers are invaded by columns of epithelial cells, while there is a small round-celled proliferation which becomes changed into connective tissue. Colloid degeneration of the primary and secondary growths often takes place.

The growth may appear as an annular band of dense hardness, the lumen of the bowel being almost obliterated ; it grows slowly, but produces obstruction early ; it is the most favourable variety for removal. The growth may be tubular in form, a considerable part of the bowel being transformed into a hard tumour ; adhesions are well marked in this variety. The disease may manifest itself as an ulceration with hard fungating edges ; in this form there is usually passage of blood and mucus from the intestine, but little obstruction. At other times a fungating mass may appear, and form a soft, rapidly-growing tumour, which spreads into the bowel, causing early secondary growth by metastasis, free bleeding, and leading to a rapidly fatal conclusion.

Above the growth the colon will be hypertrophied, and dilated in proportion to the time that it has been present. The hypertrophy is not so marked as in stricture of the small bowel, and is followed earlier by paralytic dilatation. Ulceration is common above the growth, and may lead to perforation. Dilatation and rupture of the cæcum may occur should the bowel become suddenly occluded, or when purgatives have been administered. Peritonitis may be set up by perforation, rupture, or suppuration, while plastic peritonitis may occur, causing matting together of the colon with the neighbouring parts. Fæcal fistulæ are met with which open on the surface in the region of the cæcum or the umbilicus, while internal fistulæ may occur between the colon and the small intestines or the bladder. Metastatic growths occur, but are not common. The lymphatic glands on the surface of the colon and those in connection with the bloodvessels are first affected, while the liver and peritoneum are also sometimes involved.

Symptoms.—The onset is insidious, and may remain unrecognized for several years, especially when the growth does not seriously inter-

PLATE LXII.

HIRSCHSPRUNG'S DISEASE.

Lateral view of same case as that shown on previous plate.

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fere with the lumen of the bowel. Occasionally acute obstruction occurs in a patient who has shown no former symptoms ; this is usually due to a sudden obstruction of a narrowed part of the intestine. While the growth is confined to the colon, and before obstruction becomes marked, the patient's general health remains good ; the pain may be intermittent and of a colicky type, due to the unusual contractions of the intestine above the growth. Pain becomes constant if the growth is fixed to other organs or to tissues outside the bowel. Cachexia develops rapidly when the peritoneum becomes involved. When obstruction occurs, there is tympanitic distension over the abdomen. If the obstruction be in the cæcum, the middle part of the abdomen is distended ; and when the pelvic colon is involved, the sides of the abdomen are chiefly affected. Peristaltic contractions are visible in chronic growths, being caused by the contractions of the bowel above the obstruction. Audible gurgling usually accompanies peristaltic movements.

A tumour is to be distinguished in many of the cases. When it occurs in the splenic flexure or the pelvic colon, it is liable to be concealed. It seems larger than it really is, owing to fæcal accumulation and the matting together of the neighbouring structures. When the transverse colon is affected, the large omentum is often found rolled together, and may not be distinguishable from the growth.

If fluid be injected into the rectum, it may become arrested at a certain point, and indicate the position of the tumour if it can be felt ; while emulsion of bismuth injected into the colon will show the site of the growth, if an X-ray photograph be taken. The sigmoidoscope in skilful hands will show a growth in the pevlic colon. It may be possible to palpate the growth through the rectum or the vagina.

Constipation is frequently present, but may be absent or alternate with diarrhœa, the latter being caused by inflammation and ulceration of the bowel above the site of the growth. There is a painful bearing-down sensation accompanying and following defæcation when the growth is in the pelvic colon. The fæces may contain blood, shreds of mucous membrane, and portions of the growth, and pus may also be present. These signs usually indicate ulceration or necrosis.

The most frequent complications met with are acute intestinal obstruction, perforation of the bowel, and fistulæ. Ascites is a common sign of metastasis, and arises from multiple peritoneal growths. Death may be due to toxæmia, obstruction, or general extension of the disease ; the latter is not a common cause.

Treatment.—If the disease is recognized early, the affected part of the bowel should be removed ; it seldom, however, is so recognized, but an exploratory operation should be undertaken if there be any suspicion of the nature of the case. The abdomen being opened in the middle line, colostomy may be undertaken as a preliminary to resection of the bowel, and as a palliative treatment when the latter measure is found impossible ; or in that case an entero-anastomosis may be performed instead of colostomy.

If obstruction should be present, an opening is made above the growth ; and if no exploration is justifiable, the ileo-cæcal junction is cut down upon, and if the cæcum is found distended it is opened. When the urgent symptoms have passed, further operative procedure may be undertaken. When obstruction is not present, resection of the growth is indicated where there is no metastasis or extensive adhesions. A sufficient amount of bowel should be removed to clear the growth above and below by several inches, together with a fan-

shaped piece of peritoneum, with its apex at the root of the mesentery, and containing the lymphatic glands and vessels involved in the growth. The resection may be undertaken and the new junction established at once; this is a suitable procedure in experienced hands, and where the disease involves the cæcum or sigmoid. Under other circumstances the operation had better be performed in three stages: First, the affected portion of bowel is brought outside the abdomen; next, after a day or two the diseased part is removed, and a Paul's tube inserted in either end of the bowel; finally, when adhesions have had time to form—in about a week—the ends of the bowel are freed and joined together.

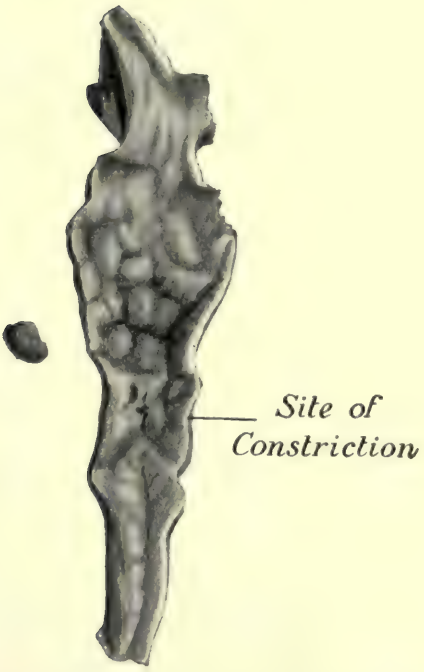
THE VERMIFORM APPENDIX: APPENDICITIS.

The normal appendix is a narrow blind tube 3 to 4 inches in length, but this may vary greatly; in diameter it measures a quarter of an inch when undistended. Its position is about one inch below the ileo-cæcal junction, where its base springs from the inner and back part of the cæcum; the corresponding point upon the surface of the skin is found at the junction of the outer and middle thirds of a line drawn from one anterior superior iliac spine to the other (Lanz). The best guide to its position is the anterior longitudinal band of the cæcum, the muscular fibres converging to the base of the appendix, and being continuous with its muscular coat. When inflamed the appendix may be found in various abnormal positions. The following may be taken as the order of position: Ileo-cæcal angle; behind the cæcum; in the pelvis; on the outer side of the cæcum; incarcerated in a retroperitoneal fossa; in front of the cæcum; and in the sac of a hernia (Lockwood). The appendix is directed upwards and outwards behind the colon, downwards and inwards over the pelvic brim, or upwards and inwards behind the ileum. The organ is composed of mucous membrane, submucous and lymphoid tissue, a very poorly developed muscularis mucosæ, some circular and longitudinal muscular tissue, subperitoneal tissue containing blood and lymph vessels, and peritoneum. The muscular fibres are sometimes defective, thus bringing the submucous and subperitoneal layers into contact. The blood-supply is derived from branches of the ileo-colic artery. A fold of peritoneum invests the appendix; it contains the artery in its free border, and forms a mesentery which is attached to the under-surface of that of the lower end of the ileum.

Appendicitis.—The disease is most common in the male sex. The cause of this is not very clear, but it has been suggested that the extra blood-supply from the ovarian artery prevents attacks of inflammation in the appendix.

It is **predisposed** to by any obstruction of the lumen of the appendix, by swelling of its mucous membrane, or by kinking of a long appendix, while constipation is an undoubted predisposing factor. Whether any fæcal concretions actually enter the appendix is not very clear. Appendicitis usually occurs in those who are otherwise in good health, although sometimes predisposition would seem to be caused by some general blood infection, especially influenza; a chill and violent exertion have been held to be predisposing causes; it is likely that when

PLATE LXIII.



VERMIFORM APPENDIX OPENED, SHOWING CONSTRICTION AND PELLET OF HARDENED FÆCES FOUND AT PROXIMAL END OF CONSTRICTION.

(Museum, Queen's University of Belfast.)

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they so act it is on an already affected organ. In like manner injury has been held to be the cause of an attack of appendicitis, but it is improbable that it will start an attack if the appendix has been previously normal. The disease seems at times to run in families, which is probably owing to some abnormal structural arrangement of the appendix or to diminished powers of resistance. Foreign bodies have occasionally been found in an inflamed appendix, but may be the result rather than the cause of the condition, and in any case are rare. Bégouin, Hamilton Russell, Rammstedt, and Lace have reported cases in which thread-worms were found in the inflamed appendix; while, on the other hand, Arboré Rally has reported a case in which they gave rise to the symptoms of appendicitis while in the intestine.

The disease is **caused** by infection with bacteria of the mucous membrane and lymphoid tissue of the appendix. The organisms commonly found are the *Bacillus coli*, either alone or in conjunction with staphylococci or streptococci. The organisms of tubercle, actinomycosis, and pneumonia, are sometimes present. An inflammation of the mucous membrane of the appendix probably allows entrance of these organisms.

Pathology.—The condition may vary from mere catarrh of the mucous membrane to a gangrenous condition of the wall; in the simpler variety the mucous membrane becomes swollen, and causes narrowing of the lumen, which may block communication between the appendix and the cæcum, the contents of the former being thus unable to pass out, and forming a suitable ground for the growth of the micro-organisms. Erosion or ulceration may take place on the epithelial surface, and thus enable the organisms to pass into the submucous tissue, from which they spread to involve the muscular and peritoneal coats. The peritoneum may become affected without any apparent perforation or ulceration. Cicatrization following inflammation may take place, and result in the formation of annular constrictions of the appendix, which may act, by causing retention of the contents of the tube, as a predisposing cause of fresh outbreaks of inflammation. The inflammation may result in the formation of **concretions,** which are usually made up of lime salts, bacteria, and material derived from the fæces; these become grasped by the walls of the appendix, either at its apex or near the middle, and may be found lying in a saccule between two constrictions. They usually increase in size by further deposit, the result being prolongation of the inflammation either by pressure or owing to retained secretions. These concretions gave rise to the old idea that the disease was caused by a foreign body, since they resemble small fruit stones or pips.

Diverticula are sometimes formed by protrusions of the mucous membrane either through a defective muscular coat, or a lymphatic or vascular space. They are very liable to inflammation.

Perforation of the appendix may be caused by the extension of ulceration from the mucous coat, by the bursting of an abscess in the wall of the appendix, or by gangrene resulting from the inflammatory changes. The latter may affect the organ in one or more small areas, or the whole of the end of the appendix may become gangrenous. It sometimes happens that, on cutting down on the appendix, it is found to be completely necrosed from its connections, and lying either in a closed-off cavity or in the abdomen. Occasionally the gangrene extends to the cæcum. Perforation the result of a local ulceration or necrosis may occur at the apex, the convex border, or at the junction with the

cæcum ; the attachment and extent of the mesentery influences the position. Perforation may also take place at the point at which a concretion is impacted, and may allow of its escape into the peritoneal cavity.

Except in very mild cases, the serous coat of the appendix is involved, and the history of the attack will largely depend upon the power of resistance of the surrounding peritoneum. Sometimes there is a formation of fibrous lymph, which by uniting neighbouring peritoneal surfaces renders the infection circumscribed. If this results, the lymph will be reabsorbed and complete recovery take place. Or it may become organized ; connective tissue is thus formed, and makes strong adhesions which interfere with the movements of the cæcum. The appendix itself may also become fixed, twisted, or kinked—a result which predisposes to recurrent peritonitis.

If the disease proceed a little further, local suppurative peritonitis occurs, and the formation of a peri-appendicular abscess. This is usually caused by perforation into a space which is already cut off by adhesions from the peritoneal cavity. The walls of the abscess are formed by the peritoneum of the iliac fossa, the cæcum and the lower coils of the ileum, and the great omentum, which overlies them and becomes adherent. A definite tumour is formed in the right iliac fossa. Recovery may now take place by the pus being absorbed, but more frequently the abscess enlarges, and breaks either through the abdominal wall or into the neighbouring viscus ; while sometimes the suppuration destroys the adhesions which have been formed, and the abscess bursts into the general peritoneal cavity, giving rise to diffuse peritonitis. The appendix may be found hanging free, or even completely separated, in the abscess cavity, or it may fail to be discovered owing to being buried in the wall of the abscess.

The situation that the abscess occupies will, of course, vary with the direction of the appendix, but it is most often found in the right iliac fossa on the inner side of the cæcum. Occasionally the abscess travels to a considerable distance from its original site, either along the ascending colon to reach the diaphragm, or into the pelvis, and it may also open into one of the hollow organs.

Should adhesions not form, the infection spreads much more rapidly, and becomes diffuse or general. The infection may be so severe that the peritoneum does not react, and only a small amount of blood-stained serum is found in its cavity ; or diffuse suppuration may take place, and pus accumulate in the pelvis and flanks, while in the upper part of the abdomen there is a serous exudate. Even when the process of suppuration is not confined to the region of the appendix, it may not become general, but be cut off in certain areas of the peritoneal cavity, thus making several accumulations of pus. Inflammation of the cellular tissue may occur in the iliac fossa, and suppuration spread between the peritoneum and the iliac fascia to Poupart's ligament, but it is prevented from entering the thigh by the attachment of the fascia to the ligament. It may also spread in the opposite direction behind the ascending colon, and become a subphrenic abscess.

Symptoms.—It is very difficult to tell by the symptoms present what the exact condition at the appendix is, or to give any prognosis, slight symptoms sometimes being present when the local condition is grave, and *vice versa ;* but, taking the average case of an attack of inflammation of the appendix in its normal position, the following may be regarded as the signs of the condition :

The patient has a sudden severe colicky pain, referred to the umbilicus in the first instance, and usually followed by nausea and vomiting. The whole abdomen is found to be somewhat tender, and rigidity is present over the inflamed area. The pain and the tenderness soon become localized in the right iliac fossa, most marked at **McBurney's point,** which is situated 1½ inches distant from the anterior superior iliac spine, in a line drawn from it to the umbilicus. The temperature rises for about twelve hours, probably reaching 101° F.; the pulse-rate is increased to about 100. As a rule there is constipation. If the inflammation does not spread, the pain will pass off and the other symptoms gradually subside, so that in about two days there is no sign of the condition, beyond a little tenderness over the region; but if, on the other hand, inflammation spread to the peritoneum, the pain becomes more severe, the lower part of the abdomen is held rigid and becomes tender, vomiting continues, the pulse becomes quicker, and the temperature remains about the same as before. If the disease now becomes cut off by adhesions, and suppuration does not take place, the symptoms will subside, and as the abdomen becomes less rigid an irregular tumour, consisting of the matted parts, may be felt; this gradually disappears. If suppuration occurs in the cut-off area, the symptoms of local peritonitis will occur, and the temperature will rise and the pulse become more rapid. On examination of the blood, leucocytosis is found to be present. The abscess increases in size and may bulge in the right iliac fossa, becomes softer and more tender; later on, fluctuation indicates that the pus is coming near the surface. At the same time œdema of the abdominal walls may occur.

In the retro-cæcal and retro-colic forms of the disease, the infection is confined behind and to the outer side of the colon. Some degree of abdominal resistance may be recognized, or the cæcum may be pushed forwards and simulate a tumour. There may be flexing of the right hip owing to irritation of the ileo-psoas.

In the pelvic form the abdominal symptoms are not so prominent, and the abscess is probably first recognized on rectal or vaginal examination. There is often a swelling, caused by the abscess in the pouch of Douglas. Urinary symptoms are due to traction of the peritoneum of the bladder, and rectal symptoms may result from pressure. A pelvic abscess at times projects above the pubes, and may simulate a distended bladder.

The abscess resulting from appendicitis, whatever the position of the tube, may rupture externally, forming a sinus or fæcal fistula; or it may burst into the rectum, when pus becomes present in the stools; into the vagina; or into the bladder, when pus is present in the urine.

If the peritoneum should become involved before there are any limiting adhesions, diffuse peritonitis occurs. This was formerly referred to as **fulminating appendicitis.** The face becomes dusky and has an anxious expression; vomiting is present, but occurs without any retching effort; the walls of the abdomen are rigid and do not move during respiration. If the case has occurred suddenly the appendix may not be indicated as the source of the infection, though there is usually some initial pain over its region to guide one. Leucocytosis is absent, and there is no swelling to be made out. The gravity of the condition will be emphasized by a subnormal temperature, a rapid, feeble pulse, and general collapse, sometimes accom-

panied by jaundice. Death may ensue within thirty-six hours, the patient usually remaining free from pain; or he may survive for several days, obstruction of the bowel from paralysis leading to a fatal end.

Diagnosis.—As a rule appendicitis is not difficult to diagnose, but in some cases there is close simulation of other abdominal affections. The signs to be borne chiefly in memory are the severe **pain** occurring suddenly in a patient in normal health, **rigidity** over one side of the lower part of the abdominal wall, and **tenderness** over the appendicular area. The order of the onset of symptoms should be borne in mind—*i.e.*, there is first pain, next nausea with vomiting, then tenderness and rigidity, and finally a rise of temperature. Local tenderness or swelling may be felt by the rectum when it is difficult to make out these signs owing to the fatness of the patient.

Diagnosis has to be made **in mild or relapsing cases** from **biliary colic,** in which there is jaundice, frequently no rise of temperature or pulse-rate, while the tenderness is to be found in the upper right part of the abdomen. From **renal colic** it is distinguished by the pain shooting down the leg or into the genital organs, and by pus and crystals, etc., being found in the urine. In the pain which is caused by **movable kidney,** that organ may be felt in an abnormal position, and there are disturbances of micturition. Mild appendicitis is also to be distinguished from **enlarged tender or prolapsed ovary** and **painful menstruation** when there is sudden onset of pain at the beginning of the period in young nervous girls, and, especially when this is associated with nausea and some rigidity, it may closely resemble appendicitis; but high temperature is usually absent, and there is probably a history of a similar illness at previous periods.

When appendicitis is associated with **local suppurative peritonitis,** it has to be distinguished from **pelvic abscess,** especially when the latter is associated with the uterus, which is felt to be fixed and in an abnormal position. **Psoas abscess** is distinguished by the presence of bone disease and the fact that the abscess is chronic. A **new growth** of the cæcum is distinguished by the history of constipation, alternating with diarrhœa, abdominal distension of old standing, and a hard tumour, which is not tender, being present in the region of the cæcum. In **early intussusception,** the tumour is not very tender, and alters in size and shape, while blood and mucus are passed by the rectum. In **colitis** there is the passage of a large quantity of mucus, or perhaps of casts, and tenderness, when present, is diffuse over the whole colon. When the **uterine appendages** are inflamed, the condition is to be made out by bimanual examination.

When appendicitis is associated with **acute diffuse peritonitis,** the diagnosis from a similar condition caused by other diseases, such as perforated gastric or duodenal ulcer, is to be made, as a rule, by the symptoms in the latter being more sudden in onset, with immediate collapse, contraction and rigidity of the abdomen, which is most marked in the upper part at first. Ruptured duodenal ulcer, however, is often difficult to distinguish, since the rigidity spreads down the right side. In other acute affections causing profuse peritonitis, such as rupture of the gall-bladder, pyosalpinx, extra-uterine gestation, and acute intestinal obstruction, other local or preceding symptoms will probably lead to a correct diagnosis.

Prognosis.—This is very indefinite, but there can be no doubt that many cases recover without operation. Bad signs are the absence

of any local resistant mass and persistent high or subnormal temperature, with rapid pulse, general abdominal distension, persistent constipation associated with vomiting, presence of hiccough, and the absence of leucocytosis.

Treatment.—The general expectant treatment is adopted in cases which show improvement within the first twenty-four hours, and in which no one symptom persists. The patient is put to bed, propped up with pillows, another pillow being placed under the knees, and kept upon a diet of milk, whey, or warm saline solution, hot fomentations being applied locally to the region of the appendix. Saline solution may be introduced by the rectum for the relief of thirst.

For cases in which from the first the symptoms are pronounced, with a rising temperature and an increasing pulse-rate, while the pain is persistent and increasing in severity, and the abdomen ceases to be moved on respiration and becomes very tender, operation is to be advised at once, and is especially imperative in young people, since in them suppuration, with gangrene of the appendix, is more common.

Operation may be called for between the second and fifth day for a spreading infection or peritonitis. In such cases, owing to the condition of the patient, the procedure resolves itself into evacuating the pus and removing the appendix, avoiding separation of the adhesions, and making provision for drainage. When vomiting persists, the stomach may be washed out. Hot saline should be injected, and small doses of calomel may be given twelve hours after the operation.

Where there is a circumscribed abscess, it may be opened and drained, or the peritoneal cavity may be opened in order to remove the whole abscess cavity with the appendix; which operation is performed depends on the condition of the patient.

Speaking generally, then, we may say that operation can be postponed in certain mild cases, when one may wait for a quiescent period, or in the hope that the condition may clear up; and in cases where the diagnosis is not very certain, especially where there is a history of ovarian and other similar troubles of the female, or where a movable kidney exists; that it should be performed at once where general distension and tenderness exist, and where there is a marked severe onset and the symptoms gradually but steadily increase; and in any case operation should be carried out when the local and general symptoms do not improve within forty-eight hours, and where there is evidence of local suppuration.

There are certain complications which may arise after operation, usually where interference has been delayed beyond the first forty-eight hours. Such are—

Secondary abscess, due as a rule to defective drainage, or to some focus of the suppuration having been left behind. It may form near the operation wound, and be discharged by it, or lower down in the pelvis, and discharge through the rectum or vagina, and occasionally a right subphrenic abscess results. **Obstruction of the bowel,** resulting from paralytic distension or from adhesions. If the symptoms do not abate, the abdomen must be reopened and the condition seen to. A **sinus** or **fæcal fistula** may result from infection, from necrosis of the wall of the cæcum, or imperfect ligature of the appendix. Other complications occasionally met with are—**thrombosis of the femoral vein, infection of the portal vein, subphrenic abscess,** and **ventral hernia.**

Chronic Appendicitis.—Patients are sometimes met with who complain of a general impairment of health, some abdominal discomfort, and difficulty in keeping the bowels normal. Physical examination usually reveals little, as there may be no local tenderness or swelling, and the diagnosis of chronic appendicitis is made usually by a process of exclusion. In such cases, however, if the abdomen is opened, it is usually found that the appendix is involved in some way, either by the presence of a concretion, twisting, or stricture, or by adhesions in its neighbourhood. Removal of the tube and the breaking down of adhesions usually lead to cure.

Recurrent Appendicitis.—This may be placed midway between the acute and chronic, in that the symptoms of the attack are frequently not very severe. The first attack is usually followed by a recurrence. The symptoms are very various. Sometimes after the original attack the patient remains well for years, or he may have another within a week or two, which is repeated, so that he is never in good health. In some cases the attacks are mild from the beginning; in others there is an acute attack to begin with, which is followed by mild attacks. There is usually discomfort in the abdomen, succeeded by pain, which may be slight or gradually becoming more severe, and may be attended or followed by vomiting. After a few hours the pain subsides, leaving a tenderness over the appendix. In some cases of recurrent appendicitis each attack is a severe one, and may culminate in suppuration.

These attacks are usually credited to some indiscretion, but it is improbable that such would take effect were it not that the appendix is already diseased.

Diagnosis.—This is not difficult if the history is known or the patient has been seen with an acute attack; but in other cases some difficulty may arise, and a mistake may be made in attributing the pain and other symptoms to colitis or adhesions of the cæcum. Pain which is the result of renal colic, movable kidney, and inflamed ureter, or disease of the ovary and Fallopian tube, may simulate recurrent appendicitis.

Treatment.—The best line to pursue in these cases is to remove the appendix at a quiescent period between the attacks, and the earlier the better, as any subsequent attack may lead to suppuration and may prove fatal.

Age Conditions.—In infants peritonitis is usually severe, and often ends fatally, but is, fortunately, not common. In children the disease is more frequent, and is serious, but not so often fatal. A little difficulty may be experienced in diagnosis, since the patient is unable to give any history; but the symptoms are similar to those met with in adults.

In elderly people involution of the appendix usually occurs, and when it becomes the seat of the inflammation gangrene is rare. The usual condition to be found is a small perforation and a large abscess.

Occasionally appendicitis occurs during pregnancy, and if occurring during the earlier months may lead to abortion. The disease may possibly be overlooked, the abdominal symptoms being attributed to the condition of the patient. The disease is often severe, and operation should be undertaken when the diagnosis is made.

Various other affections of the appendix are met with, such as **tuberculous disease, actinomycosis,** and **cancer**, but as isolated primary conditions they are exceedingly rare.

AFFECTIONS OF THE LIVER.

Abscess of the Liver.—This may be caused by trauma from without, giving access to pyogenic organisms, or may result from within by some foreign body, such as a pin or fish-bone passing through the bowel.

When due to gall-stones, the organism chiefly found is the *Bacillus coli ;* it arises from direct ulceration from gall-bladder or ducts, or by indirect infection when the stone causes ulceration in the common bile-duct.

When arising from parasites, the *Ascarides* find their way up the duct from the duodenum ; they then die, and, acting as a septic body, give rise to an abscess. *Coccidia* give rise to small multiple abscess formations.

The abscess may result from extension from neighbouring foci of inflammation, as in empyema of the right pleura, peritonitis, or perinephritis.

Pyæmic abscess may arise from pyogenic organisms finding their way through the portal vein, and are secondary to suppuration in some part of the digestive tract, appendicitis, pancreatic or splenic abscess, or following on operations for piles, etc. They may result from infection carried through the hepatic artery, secondary to middle-ear disease and septic inflammation of bone, the heart, or the lungs.

When occurring in the course of typhoid fever, the abscess is commonly due to direct extension by means of the bile-ducts.

The **tropical abscess** of the liver is met with most commonly in adult male Europeans who have resided in the East ; it is secondary to dysenteric ulcer. Alcohol is the greatest predisposing cause to tropical abscess. Abstainers seldom suffer from it.

The single liver abscess is usually of tropical origin ; apart from this it may be due to gall-stones, to parasites, or secondary to neighbouring inflammatory processes. The multiple abscess results from various causes, especially pyæmia. The most common part of the liver to be affected is the upper part of the right lobe.

Symptoms.—The chief symptoms are pain, fever, and enlargement of the liver. They are frequently remarkably latent. The abscess may bulge in the hypochondrium, producing redness of the skin : pain over the liver of an aching character may be complained of. When the pain is sharp, it usually indicates peri-hepatitis. The tumour is found to move with respiration ; fluctuation is very rarely found ; on auscultation friction sounds may be heard, and signs of pleurisy and crepitation at the base of the right lung ; while splashing sounds will occur if the abscess has burst into the pleura. The area of the liver abscess is usually enlarged in an upward direction, while the stomach and colon, together with the right kidney, may be found displaced downwards. A cough, if present, is due to irritation of the phrenic nerve or direct implication of the lung ; the *Amœba coli* may be found in the sputum. Dyspnœa may be produced from encroachment by the abscess cavity upon the chest. Constitutional symptoms are—Rise of temperature, with rigors and perhaps headache, especially in cases of injury or pyæmia, but in tropical abscess the temperature may be normal. The complexion is of a dirty type, and there is often slight jaundice. Vomiting, with diarrhœa and constipation, are often present. If the abscess should burst into the stomach, pus will be

vomited, or be passed in the stools when it bursts into the intestine. Peritonitis occurs if the rupture take place into the peritoneal cavity, and death usually results unless the patient is operated upon early. When rupture takes place the pleural cavity or lung, chest signs will be superadded to the abdominal. Sometimes the abscess bursts externally.

Diagnosis.—In the latent period the condition is very hard to distinguish, and, indeed, symptoms may not be complained of. The special signs which may be borne in mind are the pain in the right side over the liver area, which radiates to the shoulder, or may be present in the shoulder independently. An enlarged liver and a raised temperature, together with a bad complexion of a yellowish tinge, the presence of dysentery or of septic wounds, especially of the head, should be carefully considered in relation to abscess of the liver. Inflammation round the liver may simulate abscess, but the organ is not enlarged, and the symptoms are much less severe.

Treatment.—If the abscess can be located, it should be opened freely. When the parietes are not adherent to the liver, sponges should be packed round, and the parietal peritoneum sewn to the liver, before the pus is evacuated. When the abscess is situated in the right lobe above the margin of the ribs, the thoracic wall must be opened. When it communicates with the pleural cavity, part of the chest wall must be removed. Sudden bursting of the abscess, especially into the peritoneum, must be dealt with by instant operation. The result of operation in single abscess, and when pyæmia is not present, is fairly good.

Hydatid Cysts.—Hydatids are usually met with in the right lobe of the liver, but may occur in other situations. They may be single or multiple, and the symptoms will vary with the size and the number of the cysts, and also with their situation. In the case of a single cyst of large size, which projects downwards into the abdomen, a smooth, usually painless, globular tumour is formed in the epigastrium or the hypochondriac region. There is little pain, and the tumour feels elastic, or at times fluctuation may be detected, and a characteristic thrill may be felt on palpation. Sometimes the tumour appears to be solid, owing to the thickness of its walls. If the cyst is deep in the right lobe, the hepatic enlargement may be detected, but no other special sign. The tumour may project in other directions, and may bulge out the thoracic wall or push the diaphragm upwards.

Early **Symptoms** are pain felt in the right shoulder, a rash, and sickness, especially after food of a fatty nature. Pressure symptoms are liable to arise owing to the diaphragm or the stomach being impinged upon, and pleurisy may develop on the right side. If suppuration occur, hepatic abscess from other causes is simulated. Spontaneous cure occasionally takes place, or the cyst may rupture into the peritoneal cavity, one of the hollow viscera, or through the pleura. Diagnosis may be difficult, but can usually be confirmed by removal, with an aspirating needle, of some of the contents of the cyst. There is, however, in this procedure some risk of leakage, and it is well that it should be used only as a preliminary step to be followed by operation.

Treatment.—If a cyst is recognized below the costal margin, it can be operated on through the abdomen; otherwise it is reached through the thorax. When pedunculated, a ligature may be applied to the

neck and the cyst removed. When the cyst is not pedunculated, free fluid is withdrawn by aspiration, and an injection of iodine or formalin made into the cavity. Probably the best treatment is to sew the sac to the parietes, and to incise and pack the cyst or allow it to drain. If there is troublesome hæmorrhage, gauze packing may be soaked with adrenalin. This method of treatment becomes the necessary one when the contents of the cyst are purulent.

Two other forms of cyst occur in the liver: The **solitary cyst,** which projects downwards from the border of the liver, and may contain a large amount of clear fluid ; this cyst has been mistaken for one of the pancreas or of the mesentery. The usual treatment is to enucleate it. **Multiple cystic disease,** in which the liver becomes enlarged and contains a number of small cysts. The condition is often associated with cystic disease of the kidney, and treatment is of little avail.

New Growths of the Liver.—Innocent new growths are extremely rare. When present, they are usually **adenoma** or **angioma.** The former occurs as a round tumour with a capsule, and is easy of removal if single. Diagnosis is not often made previous to operation.

Carcinoma as a primary disease is rare, and when occurring is not usually recognized until too late to permit of operation.

Primary **Sarcoma** of the liver is rare. The organ usually enlarges quickly. Treatment is as a rule unavailing, though sometimes a piece of the liver with the growth is removed.

In attempting to remove a tumour from the liver, it is of the greatest importance that it should be easily reached ; if adhesions should have formed, they make the condition more difficult. The tissue should be cut clean, vessels tied slowly but firmly, and the wound united by means of catgut.

Occasionally **Gummata** occur in the liver, and may project as nodular tumours. One of these, a single gumma, may become pedunculated and resemble a new growth. The treatment, if the case is diagnosed, is that for the tertiary period of syphilis.

Deformities and Displacements of the Liver.—Occasionally a tongue of liver tissue grows downward from the right lobe to which it is connected. This is known as **Riedel's lobe** ; it may be palpated as a solid painless tumour to the outer side of the semilunar line. The condition is of little importance, except that it is often associated with disease of the gall-bladder, or may simulate floating kidney. If the patient be placed on the left side, the fingers can usually be inserted between the lobe and the kidney. No treatment is necessary for the condition in itself.

Prolapse of the liver, or **movable liver,** as it is sometimes called, may be a congenital condition due to elongation of the coronary and suspensory ligaments, occasionally to absence of the former. As an acquired condition it is due to stretching of the ligaments and laxity of the abdominal muscles, and the organ becomes displaced downwards and rotated, the upper surface coming to the front. It is sometimes freely movable, but at others is fixed by adhesions in an abnormal position (dislocated liver).

Signs.—A tumour having the characteristics of the liver may be felt in the middle or even in the lower part of the abdomen, while resonance replaces normal liver dulness. The condition frequently

gives rise to no abnormal symptoms, or there may be some pain and a feeling of weight which is increased by exertion, and the patient may suffer from wasting and neurasthenia.

Treatment.—The walls of the abdomen may be supported, and the liver, having been replaced, is retained in its normal position by a specially-made corset. The general condition should be improved by massage and tonics. Occasionally, when these means fail, **hepatopexy** may be performed. This consists in folding the upper edge of the divided parietal peritoneum over the lower edge of the right lobe of the liver, and fixing it in that position by means of sutures.

AFFECTIONS OF THE GALL-BLADDER AND BILE-DUCTS.

Gall-Stones.—This disease may be caused by anything which gives rise to obstruction to the outflow of bile, either directly or through impeding abdominal respiration, such as catarrh of the duodenum and bile-ducts, constipation, pregnancy, tumour of the abdomen, compression from tight lacing, etc. Catarrh of the biliary passages is caused by the presence of micro-organisms, especially the *Bacillus coli* or *B. typhosus*. Excess of cholesterin crystals and bilirubin are formed. Excess of carbohydrates in the diet causes diminution of bile acids, and leads to formation of cholesterin crystals.

The stones usually form in the gall-bladder, but may be found in the cystic, hepatic, or common duct. They consist of a nucleus of mucus, blood-clot, casts, crystals, or clumps of bacteria, around which is a layer of cholesterin crystals, and bilirubin with calcium salts externally. The condition is more usually met with in women than in men, in the proportion of five to one, and usually in later life. It is supposed that the greater frequency of the condition in old age, and the fact that the condition is so often latent then is due to a degeneration of the muscle tissue of the gall-bladder and its ducts.

Symptoms.—There is at first indefinite pain, with some fulness of the right hypochondrium and epigastrium. Sickness may occur independently of colic, and a yellow tinge is given to the skin ; the fæces are clay-coloured and offensive.

An attack of **biliary colic** is ushered in with a paroxysm of pain, which begins in the hypochondriac area and spreads towards the umbilicus and right scapula ; it is caused by the spasmodic contraction of the muscular coat of the gall-bladder or bile-duct arising from the irritation of the mucous membrane by inflammation or the passage of a stone. The attack usually begins in the daytime and during the course of some exercise, and it may last from a few moments to several hours ; it produces collapse, with a feeble pulse, perspiring skin, and low temperature. Sickness and vomiting occur at the end of the paroxysm; the vomited matter is as a rule bile-stained, and in rare cases a calculus has been vomited ; more commonly one is passed in the fæces.

Jaundice usually occurs from twelve to thirty-six hours after the colic ; the skin and conjunctiva are yellow, and the urine is slightly coloured, while the fæces are pale and offensive. Jaundice does not occur if the stone is lodged in the cystic duct; when the obstruction is partial, the fæces contain bile, and jaundice is not marked. A rigor may occur, the temperature rising to 103° F., or more, immediately after the colic. This is probably due to septic poisoning by ulceration at the site of the obstruction ; or the fever may be intermittent,

usually associated with catarrh of the bile-ducts and impacted calculus, or it may be remittent. Septicæmia or septic endocarditis may occur when there is suppuration in the bile-ducts.

On examination of the abdomen the liver is found to be enlarged and tender. The gall-bladder protrudes at the ninth costal cartilage as a somewhat rounded tumour which moves with respiration, and can as a rule be moved in a lateral direction. The enlargement may be due to an accumulation of gall-stones, as they are sometimes very numerous, or accumulation of pus. Enlargement of the gall-bladder usually indicates that the cystic duct is blocked, and slight jaundice may result. If the common duct be blocked, the gall-bladder is as a rule contracted. If a stone produces a marked degree of jaundice, there is usually no enlargement of the gall-bladder, whereas if there is little or no jaundice, the bladder is usually enlarged.

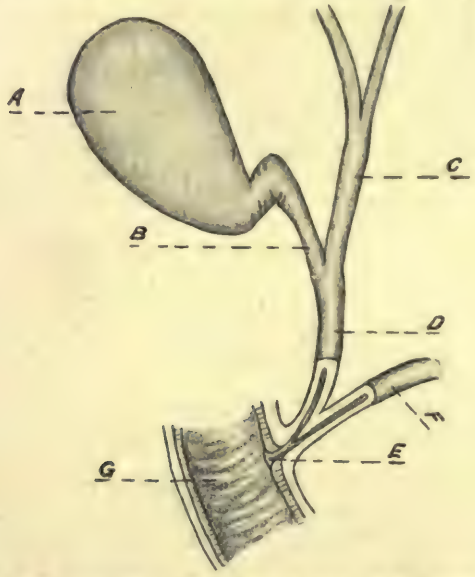


FIG. 105.—THE GALL-BLADDER AND BILE-DUCTS.
(After W. F. Campbell's "Surgical Anatomy," Saunders.)

A, Gall-bladder; *B*, cystic duct; *C*, hepatic duct; *D*, common duct; *E*, ampulla of Vater; *F*, pancreatic duct *G*, duodenum.

There are three distinct types of case m t with : that in which there are no typical symptoms, any there are being referred to the stomach (this may occur though the gall-bladder is distended with hundreds of gall-stones) ; those in which a stone is passed, giving rise to colic and jaundice ; and those in which the stone is not passed, but becomes more or less **impacted,** not producing colic, but giving rise to certain grave after-results, and to jaundice, according to the place of impaction.

Impaction.—The stone may become impacted in the neck of the gall-bladder or in the cystic duct, in which case jaundice is not marked, and the gall-bladder forms a large more or less fluid tumour ; or it may be lodged in the common bile-duct, when there is a persistent jaundice, except when the duct becomes ulcerated through at the site of or above the stone, forming a fistulous opening into the gut. A

gall-stone is occasionally lodged in the hepatic duct, and produces pronounced jaundice; there is no enlargement of the gall-bladder. The impaction may be followed by sepsis, in which case the gall-bladder becomes distended by pus; or perforation of the bile-ducts may occur, giving rise to an abscess in the neighbouring tissue, or the passage of a stone into the peritoneal cavity, setting up peritonitis. Hepatic abscess may also be secondary to the septic condition. Impaction may be followed by adhesions to the stomach and intestines, and the formation of fistulous openings; by ulceration and intestinal obstructions; by obliteration of the gall-bladder, or ulceration which produces cicatrization and obstruction of the ducts; by cancer from irritation; or by chronic pancreatitis when in the ampulla of Vater (opening of common bile and pancreatic ducts); and it may also lead to adhesions and ulceration through the anterior abdominal wall.

Diagnosis.—In a case where there is acute colicky pain and jaundice, especially when associated with an enlarged gall-bladder and typical fæces, perhaps containing a stone, the diagnosis is not very difficult.

The condition has to be distinguished from—Renal colic, in which the pain radiates into the pelvis and the leg, is associated with irritation of the bladder, and the presence of crystals in the urine.

From lead-poisoning with colic, in which there is usually chronic constipation, a blue line upon the gums, drop-wrist, and other signs of lead-poisoning.

From gastric ulcer, in which there is a close relationship between the pain and the taking of food.

From duodenal ulcer it is often difficult to distinguish the condition, except that the jaundice is usually absent or not marked; both conditions may be present at the same time, and may have a certain relationship to one another.

From cancer of the head of the pancreas, in which there is a fixed tumour, which is associated with a high degree of jaundice and loss of flesh.

Ziemssen has suggested the following test of the nature of a tumour in the region of the gall-bladder: The large intestine being distended with air, if the tumour is pushed up by the intestine, and the resonance is below it, the tumour is a dilated gall-bladder; if the tumour is pushed downwards or backwards, and the resonance is in front of and above it, the tumour is in relation to the kidney.

Treatment.—For the attack of colic morphia should be administered, in combination with atropine. Sometimes it is necessary to give chloroform to relieve the condition. A hot bath is often helpful, and the administration of a quantity of warm water containing bicarbonate of soda and salicylate of soda may lead to an increased flow of bile. For the cure of gall-stones many medicinal procedures have been adopted, such as a course of treatment at Carlsbad, repeated small doses of calomel, and a special diet and exercise, both for the removal of the stones, to prevent their further formation, and to promote a more healthy constitutional condition.

Operative treatment is indicated when there is an enlarged gall-bladder, frequent attacks of colic, persistent jaundice and fever, or when peritonitis results as a consequence of the disease. When the stones are in the gall-bladder, cholecystotomy is performed. When a stone is lodged in the cystic duct, it should, if possible, be pushed back and removed through the gall-bladder, or, failing this, the wall

of the duct is incised, the stone removed, and the incision sutured. When it is lodged in the common bile-duct, it may be pushed forwards into the bowel, or, if that is impossible, removed where the impaction occurs ; while if the stone is in the third part of the duct, or the ampulla of Vater, removal must be carried out by opening the duodenum and removing the stone through its anterior or posterior wall.

Biliary Fistula.—Fistulæ may form when impacted gall-stones are untreated. The **external** fistula is usually caused by an impacted gall-stone forming an abscess, which in turn ruptures ; or by penetrating wounds of the gall-bladder or ducts. Many other causes are, however, found at times, such as traumatic abscess of the liver ; as a result of operations about the liver and gall-bladder. Occasionally the condition is due to malignant disease, or is congenital. The fistula is usually situated at the umbilicus or in the right hypochondrium, but may be in the hypogastrium or the inguinal region.

The **Symptoms** of the condition are discharge of blood, mucus, bile, or pus. If the bile is entirely discharged, as when the common duct is blocked, the patient experiences great inconvenience, but does not suffer from lack of nutrition or digestive troubles so much as might be supposed. The prognosis of the condition is good, unless it be due to malignant disease or an impermeable stricture.

Treatment.—If the cystic duct be blocked, indicated by a discharge of mucus only, the gall-bladder may be removed. When the common duct is blocked, the obstruction should be removed, if possible ; otherwise the discharge of bile may be remedied by performing cholecyst-enterostomy.

The **internal** fistula is caused by ulceration of the gall-bladder into the stomach, colon, or other part of the intestine, or into some neighbouring hollow organ. When into the stomach, gall-stones or bile may be vomited ; if into the intestines, bile and stones may be passed in the stools, and the condition remain unrecognized. If retained, the stones may cause obstruction or become encysted.

The **Treatment** of the condition is to separate the organs, suture the opening, and remove the gall-bladder.

Carcinoma of the scirrhous type is met with in the gall-bladder, and is usually associated with gall-stones ; infiltrating the walls of the organ, it produces a hard tumour in its place. When cancer occurs in the bile-ducts, it usually begins as a papillary or submucous growth, which constricts the duct and gives rise to symptoms of indefinite pain and the gradual onset of jaundice. Diagnosis is very difficult.

Treatment.—The gall-bladder, with a portion of the liver and the infected glands, may be removed with some measure of success. When the ducts are affected, the gall-bladder may be opened and a biliary fistula established. This relieves the symptoms. Sometimes cholecyst-enterostomy may be performed with advantage.

Infective Conditions of the Gall-Bladder and Ducts—Cholecystitis.—The condition is usually associated with gall-stones, but may be independent of them and due to pyogenic infection alone. In this condition the walls of the gall-bladder are thickened, and the cavity first distended, and finally contracted. The colic is less severe when the condition is unassociated with gall-stones, but there is marked tenderness below the costal margin. The organisms concerned are

usually the colon or typhoid bacillus. When suppuration occurs, the condition is referred to as **empyema** of the gall-bladder, which is in most cases associated with gall-stones and obstruction of the cystic duct. The abscess may burst externally or internally; in the former case adhesions are usually formed. The bladder should be opened and drained, after packing off the peritoneal cavity in cases where adhesions have not formed.

Acute Phlegmonous Cholecystitis.—In this variety there is a necrosis of one or more parts of the gall-bladder with perforation, and peritonitis of a very malignant type is set up before there is time for any protective limiting adhesions to form. Gall-stones are usually present. The gall-bladder is opened or removed, and the peritonitis treated on general principles.

AFFECTIONS OF THE PANCREAS.

Pancreatitis.—This is usually due to bacterial infection, the organisms gaining admission through the pancreatic duct from the duodenum or the common bile-duct. It is often associated with cholecystitis, gall-stones, and catarrh of the stomach and duodenum. Sometimes the infection reaches the gland through the blood-stream or by direct extension. In the **acute variety** there is sudden onset, the patient feels extremely ill, and there is severe pain in the epigastric region, frequently associated with vomiting and collapse. There is distension and some tenderness of the upper part of the abdomen. The temperature usually rises, and death may occur within two or three days.

Hæmorrhagic Pancreatitis is the name given to acute pancreatitis when associated with bleeding into the gland. The onset in this case is very acute, and a large swelling may form in the upper part of the abdomen.

In the **subacute** varieties the patient usually lives for a longer period, and suppuration occurs, the pus either being collected as an abscess or being diffused through the gland. The symptoms, while similar to those of the acute variety, are rather less severe. The temperature in this case is variable, and there is less collapse; diarrhœa occurs, and blood and pus may be passed in the stools; rapid loss of flesh takes place; there is marked tenderness, and a definite swelling may be detected over the pancreas. The abscess may become subphrenic, may form as a peri-renal one, or in the position of an iliac or psoas abscess; or it may burst into the peritoneal cavity. It may also point on the surface.

Chronic Pancreatitis usually arises as a result of the presence of a gall-stone in the end of the common bile-duct, which obstructs the pancreatic duct, stops up secretion, and leads to infection. It may also follow catarrh of the stomach and duodenum, and occasionally follows an acute or subacute attack. The onset of the disease is usually gradual, but occasionally it is sudden and associated with pain and jaundice. The former may be continuous or paroxysmal, and is felt in the epigastrium and referred to the kidney and shoulder; jaundice is well marked, and becomes deeper with the continu-

ance of the paroxysms. Digestive disturbances are marked, and there is considerable loss of flesh ; diarrhœa occurs, and the stools are large, of an offensive character, and contain free fat. Hectic fever and rigors may occur. The head of the gland may be felt as a hard swelling, and easily mistaken for malignant disease.

Different varieties have been described : **Syphilitic,** usually congenital in young children. **Interlobular,** in which case only the tissue between the lobules is affected. Glycosuria is absent. This is the usual form which arises from infection through the duct. **Interacinar:** In this variety the disease penetrates the lobules. Glycosuria is present.

Signs and Symptoms.—These will vary a good deal with the causation. If the disease follows obstruction by a gall-stone of the common duct, the history will point to the condition, and the patient suffers from jaundice and loss of flesh, while there is pain in the region of the epigastrium, the left renal and subscapular regions. When secondary to inflammation of the duodenum, etc., pain is not constant, nor is jaundice marked, and there are general symptoms of interference with digestion.

Diagnosis.—The condition is usually confused with chronic cases of gall-stones or cancer of the head of the pancreas. Special attention should be given to the progressive wasting and to the jaundice and dyspeptic symptoms in chronic pancreatitis ; also the chemical examination of the fæces, which are acid in reaction, thus differing from that in jaundice arising from other causes ; and to the special reaction of the urine.

In cancer of the head of the pancreas, the onset is usually the reverse of sudden, and is not accompanied by pain ; there is a progressive diminution of health, usually in older people. Jaundice, when it comes, is absolute. In gall-stones a diagnosis may perhaps be made by the fact that there is colicky pain without jaundice, and severe pain followed by jaundice ; but frequently the diagnosis is not made until the operation.

Treatment.—In acute pancreatitis the treatment consists, when the diagnosis is established, in exploring and draining the organ, scraping away any necrosed tissue, and packing the cavity with gauze. The diagnosis is only certainly established in the course of the operation by finding swelling and hæmorrhage in the region of the pancreas, and fat necrosis, which is shown by small white areas scattered over the omentum and mesentery. In the subacute variety the pus, if present, is evacuated, and drainage established through an opening in the costo-vertebral angle, after having isolated the peritoneal cavity. In chronic pancreatitis remove any obstruction, such as gall-stone, from the junction of common bile-duct and pancreatic duct (ampulla of Vater). When there is no obvious obstruction, the bile-ducts should be drained by the operation of cholecyst-enterostomy.

Calculus of the Pancreas.—This is rare, but occasionally met with in association with pancreatitis. When present, it gives rise to symptoms which simulate biliary colic. The pain and tenderness are usually in the middle line, or referred to the mid-scapular region. If the main duct is blocked at its outlet, jaundice may be caused by pressure in the common bile-duct. The condition gives rise to diarrhœa, and is frequently associated with diabetes. If it is recognized, the calculi should be removed.

Cysts of the Pancreas.—These originate in the substance of the gland, and are generally secondary to inflammation. Occasionally the cysts are of the nature of adenomata. They may possibly be due to the blocking of the duct, as by calculus, pressure, or fibrosis, and are therefore of the nature of retention cysts.

What are called **false cysts** may also be present, and are usually due to injury, and may develop within a few days of the trauma or not for some time after it. They may be formed by the filling of the lesser peritoneal sac by fluid which has exuded from the pancreas as the result of the injury. **Congenital cysts** are also occasionally met with; **hydatid cysts** are very rare; **hæmorrhagic cysts** may result after the absorption of blood from a cavity in or near the gland.

Signs and Symptoms.—The cyst is usually situated in the body of the gland, and may be of very large size. The inner wall is usually smooth; tense adhesions are usually present. The contained fluid is dark and mucoid, and contains pancreatic ferments. The cyst forms a fluctuating ovoid tumour of the abdomen, situated at about the level of the umbilicus and a little to the left side. On percussion there is usually an area of dulness, which is surrounded by a tympanitic area. The cyst in its growth extends in a forward direction, and comes into relationship with the anterior abdominal wall either (1) between the stomach and the liver, (2) between the stomach and the colon, both organs being slightly in front of it (this is the most common situation), or (3) it may press forwards between the layers of the transverse mesocolon, the colon being in front of the cyst, and sometimes above or below it.

Symptoms are present, either due to pressure on the stomach, the colon, or the diaphragm, and sometimes on the common bile-duct, giving rise to jaundice. Loss of flesh may be a marked symptom. The cysts are to be distinguished from those in the mesentery and ovary and from tumours of the kidney.

Treatment.—This usually consists in draining the cyst. The abdomen being opened, its situation is examined, and in its common one, between the stomach and colon, the cyst is best exposed by the division of the gastrocolic omentum. If possible, the wall of the cyst is sutured to the parietal peritoneum. If this is impracticable, the cavity of the peritoneum is shut off by packing with gauze. Drainage is provided for by an opening in the left side. Extirpation of the pancreatic cyst is rarely possible unless it is situated in the tail of the gland.

Tumours of the Pancreas—Carcinoma.—This may be present in any of its varieties. It is usually situated in the **head** of the gland, and may spread from there in various directions. There may be no symptoms, when present, they are largely those of pressure; pain, which is usually gradual at the beginning, may be later severe in character; jaundice, with considerable enlargement of the gall-bladder, is of a chronic type. The tumour is rarely felt. It is frequently accompanied by some enlargement of the liver. Later on there is rapid wasting, vomiting, copious and foul diarrhœa. Biliary obstruction may occur, and also pyloric obstruction; while ascites may arise from pressure upon the portal vein or the vena cava. It may be possible to relieve these symptoms by cholecystotomy or cholecyst-enterostomy, but removal of the tumour is very seldom possible. It may be diagnosed from gall-stones by the fact that the onset of the jaundice

is not attended by pain, the enlargement of the gall-bladder, and progressive, rapid emaciation. Other conditions may be simulated, in which it is difficult or impossible to diagnose the disease.

Adenoma and **Sarcoma** of the pancreas are occasionally met with.

AFFECTIONS OF THE SPLEEN.

Abscess.—This is usually secondary to endocarditis, pyæmia, enteric fever, or malaria, and arises from septic embolus. It may burst externally, or may rupture into the peritoneal or pleural cavity, or into a neighbouring organ or the retroperitoneal tissue. The **Symptoms** are enlargement of the organ, together with abdominal tenderness and some rigidity on the left side; there is rapid loss of flesh, rigors, and sweating. Peritoneal friction may sometimes be heard over the swelling. The condition is rarely accurately recognized; if it is, an opening may be made in the abdomen, or by the trans-pleural route, and the abscess drained. This line of treatment is specially indicated when the organ is adherent. If not adherent, and if cysts are present, it is recommended that the organ should be removed.

Tumours and Enlargements.—In enlargement of the spleen a mass is felt in the left hypochondrium, and occasionally its sharp notched edge may be recognized. The tumour moves with respiration, and is dull on percussion in front, but not behind.

The primary new growths met with in the spleen are usually of a **sarcomatous** nature, and give rise to a quickly-growing tumour having a nodular feeling and being very tender. The organ should be removed. **Tuberculous disease** is occasionally met with. If recognized, the organ should be removed.

Banti's disease is accompanied by enlargement of the spleen and anæmia. The leucocytes are diminished in number, and later on pigmentation of the skin and cirrhosis of the liver, with jaundice, develop. In the early stages of this disease, before jaundice has appeared, removal of the spleen is indicated to check the disease.

In **malaria** and **leucæmia** there is great chronic enlargement of the spleen. The latter condition is accompanied by leucocytosis. When this is present, operation should never be attempted, owing to the risks of hæmorrhage. In malaria the spleen is occasionally removed, but it is not clear that any benefit results therefrom.

Floating Spleen.—This is occasionally met with in multiparæ. The pedicle is found to be long, and the organ may be found in any part of the abdomen, and even in the pelvis. The wearing of a belt helps the condition, but if marked, and the organ is healthy, it should be fixed in its proper position by operation (splenopexy).

CHAPTER XXVII

HERNIA

Inguinal hernia: Oblique, direct, congenital, infantile, interstitial—Femoral hernia—Umbilical hernia—Ventral hernia: Hernia in the linea alba, divarication of recti—Cystocele—Pathological clinical conditions of hernia.

THE definition of a hernia as a protrusion of a viscus through an opening in the walls of the cavity in which it is contained shows that by the term may be meant a protrusion of any viscus through any wall, but "hernia" usually means the bulging of a portion of intestine through a part of the lower abdominal wall, which may be weakened owing to the transmission of certain structures in the course of development.

In the perfectly-developed individual such weakness is largely theoretical, since it never gives rise to any pathological condition. In others, however, it is a potential cause of hernia.

There are various causes of hernia, which may be divided into **predisposing and exciting.**

Under the former heading come such congenital conditions as the non-obliteration of the prolongation of the peritoneum known as the "funicular process," which in the male accompanies the testicle in its descent from the abdomen, and in the female passes along the round ligament ; an inherited weakness of some part of the abdominal wall, giving an unusual patency of the rings ; late descent of the testis, leading to weakness or actual hernia.

Under exciting causes a foremost place must be given to anything which increases the intra-abdominal pressure, as, for example, the lifting of heavy weights or a sudden strain. A violent jerk—as when falling some distance on the feet or knees—may sometimes give rise to the condition.

The so-called "congenital hernia," due to the non-obliteration of the funicular process, may not manifest itself till adult life, and perhaps not even then, unless some severe strain be experienced.

It should be remembered that a man may be the subject of inguinal hernia in a marked degree, and yet not be conscious that he has anything the matter with him beyond "a swelling" which he sometimes notices. Such a case was seen lately, when advice was sought by a highly educated man, because he thought it better not to run any risk, having noticed that there was at times some swelling about the testis. On examination, complete double inguinal hernia was found.

Hernia the Result of Accident.—A fruitful source of litigation under the Workmen's Compensation Act is the production of a hernial

protrusion, alleged to be the result of injury to a workman while engaged at his employment.

When a workman claims compensation for a hernia said to have been produced by his occupation, the following points should be attended to :

1. Was there a pre-existing weakness, congenital or otherwise, which would markedly predispose him to such an injury ? If there was, then the accident was only an exciting agent.

2. Was there a pre-existing congenital sac, or so slight as not to be noticed by the individual, but only requiring a severe strain to make it apparent ? If so, the workman cannot claim that the accident was the chief cause of the condition complained of.

3. Was there a pre-existing hernia which the employé paid no attention to till an injury to the part drew his notice to it ? In such a case the workman may honestly believe that the condition was not present prior to the happening of the accident. Careful questioning and examination will probably reveal the truth of the matter.

" In a recent hernia produced by accident, at the time the workman is examined for the purpose of compensation, the protrusion will take the form of a bubonocele ; the external ring will not be widely dilated or the abdominal aponeurosis thinned out. It must be rare for a hernia to be forced right down into the scrotum by injury, even when there is a patent funicular process. In the majority of cases, when hernia follows an injury there has been a congenital sac present. The occurrence of strangulation in an old-standing hernia is sometimes attributable to injury occurring in the course of a man's employment."—Thompson and Miles (" Manual of Surgery ").

Constituents of a Hernia.—The **sac,** which consists of peritoneum pushed down by the contents, is usually now held, except in pure traumatic hernias, to be derived from a **diverticulum of the peritoneum present at birth.** The part of the sac which is constricted at the outlet from the abdomen is called the " neck," the dilated lower portion the " fundus." In early cases the sac can be pushed back into the abdomen, but later it becomes fixed outside. Inflammation of the sac produces thickening of the walls and adhesion to the surrounding tissues and to the contents. Sometimes the sac is hour-glass in shape. A hydrocele of the sac may arise from obliteration of the neck.

The **coverings** of the hernia consist of derivatives from the layers of the abdominal wall which is traversed by the particular hernia. These tend to become matted together or thinned out, and are frequently not separable from one another.

The **contents** of the sac may be small intestine, called **enterocele.** When only a part of the circumference of the intestine protrudes, the term **Richter's hernia** is applied to the condition. Omentum alone may be present, when the name **epiplocele** is applied. This form is likely to become fixed by adhesions and irreducible, while cysts may develop in connection with it. Loose bodies derived from tags of omentum or appendices epiploicæ may be present. Occasionally the colon or cæcum is present in children, and the bladder has been met with, usually the fundus or a lateral saccule. **Littré's hernia** is the name given to one which contains a Meckel's diverticulum. Any viscus except the pancreas may be found in the hernial sac, but the small intestine and the great omentum are the structures usually met with.

VARIETIES OF HERNIA.

Inguinal Hernia.

This may be **oblique** (indirect) and **direct.**

Oblique.—This variety is the one most commonly met with. It may be **acquired** or **congenital, infantile** or **interstitial,** but is nearly always predisposed to by a congenital condition. It passes through the internal abdominal ring external to the epigastric artery, while the **direct** variety leaves the abdomen internal to the artery, in Hesselbach's triangle, between the outer border of the rectus muscle and the epigastric artery. Two varieties of direct inguinal hernia are recognized —viz., the external, which leaves the abdomen between the epigastric and the obliterated hypogastric arteries; and the internal, which leaves between the hypogastric artery and the outer border of the rectus muscle.

A hernia may be **complete,** when it descends into the scrotum or labium, or it may be **incomplete**—a bubonocele—when it lies between the internal and external rings of the abdomen, covered by the external oblique.

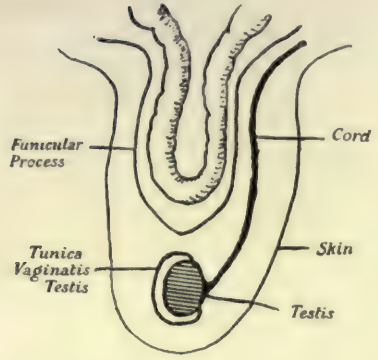
Acquired Hernia.—The sac is formed by the parietal peritoneum. It develops slowly as a rule, and is often incomplete. In the early periods it is above and distinct from the testis, but in late stages it comes to lie in front of it. The structures of the cord are spread out over the wall of the sac.

Congenital Hernia.—The sac is formed by the funicular process of the peritoneum. It may arise in infancy, or not present itself till adult life, when its formation is usually rapid, and tends to become more or less complete soon after its appearance; in some cases it does so at once. It is most common upon the right side, is liable to strangulation, and the structures of the cord are adherent to the sac. In the **funicular** variety the sac is situated above, and is distinct from the tunica vaginalis testis. In the **vaginal** form the sac is continuous with the tunica vaginalis.

Robert Campbell has pointed out that it is quite an exception to meet with a congenital hernia of the vaginal variety—*i.e.*, one in which the sac is continuous with the tunica vaginalis testis—and he gives the percentage of his cases at the Belfast Hospital for Sick Children at 95 per cent. of hernias into the funicular process having no communication with the tunica vaginalis, and only 5 per cent. in which the process was not obliterated below. The mistake is often made of thinking that the process is continuous with the tunica vaginalis because the sac may be adherent to the small pouch surrounding the testis, which may resemble a button upon the end of the sac; but on careful dissection the two are in most cases found to be separate. In other cases a connection by means of a fibrous cord is present between the sac and the tunica, but this cord is not pervious. It will therefore save confusion in the student's mind if he regards **congenital hernia as one into the funicular process, owing to non-obliteration above; while in about 5 per cent. of the cases a direct communication of the sac with the tunica vaginalis exists, owing to non-obliteration below as well as above**; and in a few cases there is a non-permeable fibrous band, connecting the sac with the tunica.

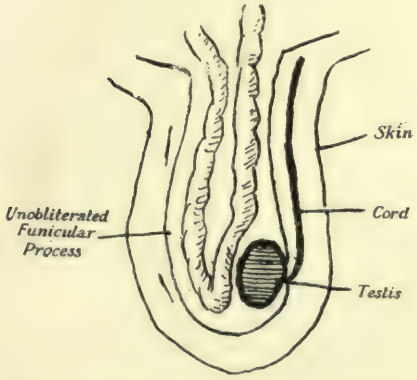
Infantile Hernia.—This term has no relation to the age of the patient, and may occur at any time, mostly in adult life. It is a

PLATE LXIV.



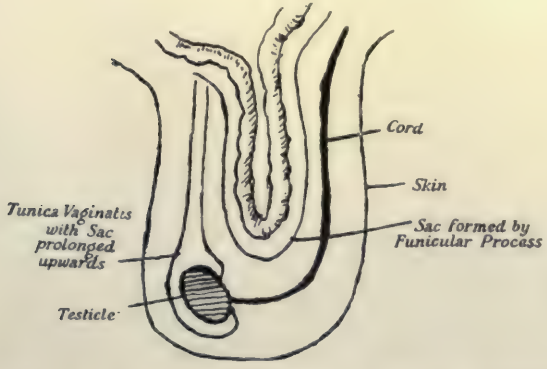
CONGENITAL HERNIA (FUNICULAR OR USUAL TYPE).

There is no communication between sac and the tunica vaginalis testis.



CONGENITAL HERNIA (VAGINAL OR UNUSUAL TYPE).

The sac is continuous with the tunica vaginalis testis.



INFANTILE HERNIA (ACCORDING TO HAMILTON RUSSELL).

The sac lies in front of the tunica vaginalis testis, which is unobliterated below.

(After Rose and Carless.)

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rare condition, and consists, according to Hamilton Russell, of a hernia into the funicular process, which forms the true sac, while a diverticulum, prolonged upwards from the tunica vaginalis, lies in front of it, and is sometimes mistaken for the hernial sac. The condition is accounted for on the supposition that during the descent of the testicle a portion of the peritoneum forming its covering has been caught and fixed to the wall of the abdomen outside the external ring. On cutting down on the hernia, three layers of peritoneum are divided, two forming the walls of the diverticulum, and the third the anterior wall of the funicular process, or true sac. The condition cannot be distinguished clinically from other forms till the time of operation. A subdivision of infantile hernia is the **encysted,** in which the sac is invaginated into the diverticulum, which lies round it, so that, in cutting down on the hernia, only two layers of peritoneum are divided—the anterior layer of the diverticulum and the anterior layer of the hernial sac.

Interstitial Hernia.—By this is understood a congenital oblique hernia, the result of the formation of a diverticulum of the vaginal process, in which the sac forms in the interstices of the abdominal wall, being made up of two or more spaces which open into the abdomen by one common orifice. The outer space is in the inguinal canal, the inner one extends between the abdominal wall in one of three situations : (1) Between the fascia transversalis and the peritoneum, forming the intraparietal variety ; (2) between the external and internal oblique muscles, forming the interparietal variety ; (3) between the external oblique and the skin, forming the extraparietal variety.

Hernia associated with Retained Testis.—The testis may be retained in the abdomen, or, more usually, come to lie in the inguinal canal. The organ is often undeveloped, and may be exquisitely tender. The hernia is into the funicular process, and may descend immediately before the testis, simultaneously with it, or follow it after an interval. The first is the most common. The testis should be brought down and fixed in the scrotum, or, if this is not practicable, and especially when the organ is in a very undeveloped condition, it should be removed. The hernia is then treated by ligaturing the patent neck of the process and removing the distal portion.

Hernia into the Canal of Nuck.—In the female the process of peritoneum which accompanies the round ligament is usually obliterated at the time of birth, but it sometimes remains open and forms the sac of a hernial protrusion, and at times contains an ovary and Fallopian tube.

Direct Inguinal Hernia is probably always acquired, though R. W. Murray believes that there exists a congenital diverticulum of peritoneum which passes through an opening in the fibres of the conjoined tendon. It generally appears in later life, and is predisposed to by weakness of the internal oblique and transversalis muscles, and comes through the abdominal wall, piercing or carrying with it the conjoined tendon instead of the internal ring. The openings are usually large and patent, and situated nearly opposite to each other. The epigastric artery is found on the outer side of the sac, and the outer border of the rectus on the inner. The cord is felt to the outer side of the sac. This type of hernia is often incomplete, forming a bubonocele, and rarely goes into the scrotum. It is more difficult to

cure than the oblique variety, by reason of the laxity of the muscles, the large opening, and its direction. It is frequently bilateral.

Coverings of an Inguinal Hernia.—The coverings from without inwards are skin and fascia, intercolumnar fascia derived from the external oblique, cremasteric fascia from the internal oblique, infundibuliform fascia from the transversalis fascia, subserous fatty tissue, and peritoneum forming the sac. In the external direct variety the transversalis fascia replaces the infundibuliform ; in the internal direct the transversalis fascia and conjoined tendon replace the infundibuliform and cremasteric coverings.

General Signs and Symptoms of Inguinal Hernia.—The hernia when down forms a rounded tumour, situated in the groin above Poupart's ligament, or may extend downwards to the scrotum. The swelling may disappear on the patient lying down, or can be returned into the abdomen by the fingers, unless when there are adhesions, but reappears from above downwards when he stands up. The direction in indirect cases is upwards and outwards, in direct cases straight back. The hernia usually slips back, when reduced, with a little gurgle. There is an expansile impulse on coughing or straining, and the swelling increases in size.

Diagnosis.—The condition is distinguished from retained testis by the absence of that organ from the scrotum ; by the " testicular sensation " on pressure of the swelling ; and by the facts that it cannot as a rule be reduced, that there is no expansile impulse on coughing, and that its upper limit can be felt. From swellings of the cord, such as hæmatocele and hydrocele, it is distinguished by the impossibility of reduction, the absence of expansile impulse, and the fact that the upper part of the swelling can usually be felt. From femoral hernia it is distinguished by the freedom of the inguinal canal, and the fact that the swelling appears first below Poupart's ligament. From an abscess it is distinguished by signs of pre-existing disease, presence of fluctuation, and the indefinite outline ; from enlarged glands by the absence of expansile impulse, and their non-reducibility.

When a hernia descends into the scrotum, it has to be distinguished from varicocele, which feels like a bag of worms, and does not as a rule extend into the canal, and if emptied of blood returns from below upwards. It will also have to be distinguished from hydrocele by translucency and absence of expansile impulse, and from hæmatocele by the weight, hardness, absence of thrill, and irreducibility.

When the hernia is irreducible or inflamed, it has to be distinguished from glandular swelling and acute abscess ; when complete, from solid enlargements of the testis, which feel much more heavy, give no impulse, and are slow in development. The history is always an important point in diagnosing hernia.

Treatment.—Palliative treatment consists in wearing a mechanical device, usually a truss, which is a padded belt, with a stout spring, which encircles the body, and is fitted with a pad at one end, by means of which pressure is applied over the internal abdominal ring. The measurements for the truss should be taken round the pelvis below its crest, meeting in front above the symphysis pubis, the measurement being given in inches. A truss to be of any use should retain the hernia at all times, and should be comfortable. It should be light and strong, and fit accurately. It should be adjusted after the

contents of the hernia have been reduced, and be applied when the patient is in a recumbent position, the pad exerting its pressure in an upward and backward position. The truss should be worn whenever the patient is in an upright position, and be applied before he rises in the morning. The varieties of truss are the rat-tail, in which the pad is prolonged downwards to form a tail attached to a leg-strap ; and the forked-tongue truss, in which the pad has two processes, attaching to a leg-piece and to the cross-strap. Trusses should only be advised when operation is contra-indicated. They are of no use to cure hernia in adults, and, while they may do so in infants, operative procedure is more satisfactory.

The radical treatment should be carried out in healthy adults, especially those engaged in active employment, in whom the hernia is not of such a size as to render it unlikely that the viscus will be retained when returned to the abdomen, or whose abdominal walls are not weak, or the external ring a very large size. In these latter conditions operation is contra-indicated. It is sometimes stated that operation should be avoided in infants under one year, as the truss may cure the condition. There seems no good reason for this view, as the operation is usually not of a severe nature, and the result of the matting together of the tissues induced by a truss is by no means ideal, and may lead to the development of hernia at a later age, when the patient takes active muscular exercise.

The procedure usually adopted is Bassini's operation, or some modification of it. It consists in cutting down upon the hernia ½ inch above the inner half of Poupart's ligament, defining and separating the sac; after examination it is tied at the neck which is carefully freed and cut off. In children it is only necessary to unite the skin and fascia, but in adults the arched fibres of the internal oblique and transversalis are united to Poupart's ligament, the cord being in front of this new union or left between the transversalis fascia and the conjoined tendon, the external oblique is thus united. There is a growing tendency to regard the freeing of the neck as the essential point in treating hernia, and, that being done and securely tied, to leave the abdominal walls alone, unless in cases of exceptional laxity.

In congenital hernia of the vaginal variety, where the sac is continuous with the tunica vaginalis, it is divided in the middle, leaving the peritoneum to cover the testicle, and cutting off the upper part, after transfixing and ligaturing it at the internal ring.

Femoral Hernia.

This variety is usually met with in women after puberty. The hernia comes out through the crural ring, down the crural canal, which is the innermost portion of the femoral sheath, and emerges in the thigh through the saphenous opening. This form of hernia occurs most frequently in the female, probably on account of the width of the pelvis, the size of the crural ring, and the fact that Gimbernat's ligament is less strongly developed in woman than it is in man. It is usually thought that the sac of a femoral hernia is derived from the stretching and bulging of the parietal peritoneum, and therefore acquired ; but, in common with most forms of hernia, there is a growing belief that it is derived from a congenital diverticulum.

Relations.—In front is the transverse thickened part of the femoral sheath, Poupart's ligament, the iliac part of the fascia lata, and the

cribriform fascia ; on the inner side is Gimbernat's ligament ; on the outer the femoral vein ; and behind the pubic bone the pubic part of the fascia lata and the pectineus muscle.

Coverings.—These are skin and fascia, cribriform fascia, femoral sheath derived from the transversalis fascia, subserous tissue forming the septum crurale, and the peritoneum. The **contents** are usually small intestine, and sometimes omentum, large intestine, ovary, and Fallopian tube.

Signs and Symptoms.—A swelling appears below the inner end of Poupart's ligament ; the neck lies to the outer side and below the pubic spine, while the neck of an inguinal hernia lies above and internal to the spine. The hernia is painless as a rule and is reducible usually without a gurgle. There is an expansile impulse on coughing. It is often met with in stout women, may be very small, and unrecognized for a long period.

Diagnosis.—In stout women it is often difficult to distinguish a femoral from an inguinal hernia ; the position of the neck given above is the best guide. It has also to be diagnosed from lipoma, which as a rule remains the same size, and is of long standing ; from a psoas abscess, which has a history of former disease, and descends behind the femoral sheath. Varicose pouching of the upper end of the saphena vein may resemble hernia. Both may disappear on pressure, but in the case of varix the swelling reappears in spite of pressure over the crural canal, and varicosity of the veins of the leg is usually present. Large tuberculous glands which protrude into the crural canal are very difficult to distinguish from an irreducible femoral hernia.

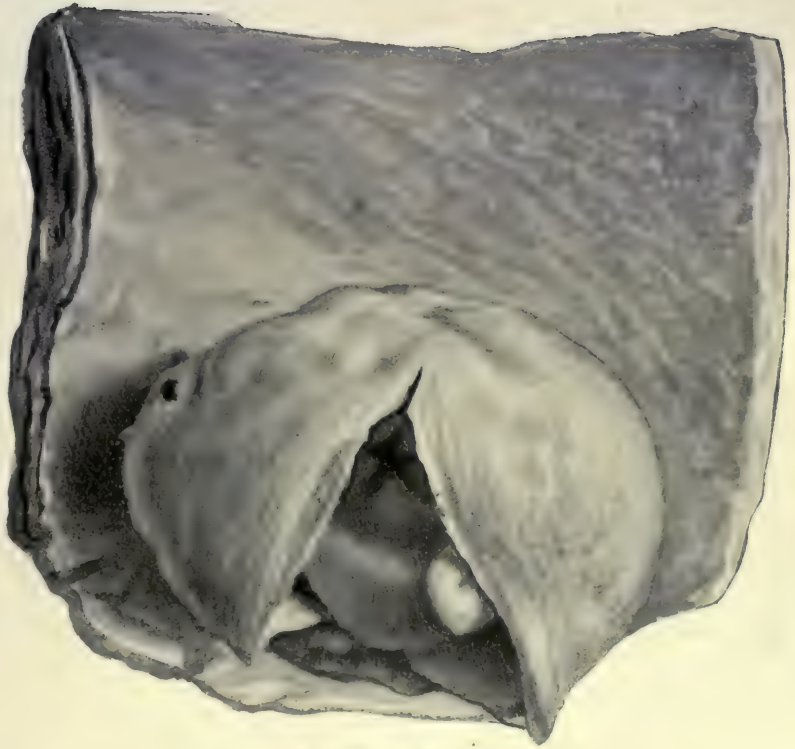
Treatment.—Treatment by a truss is not satisfactory, since it interferes with the free movement of the limb, and causes pressure on the vessels. Operation should be advised for all fit subjects, and is, of course, demanded where the hernia is irreducible or cannot be properly controlled by a truss.

The difficulty of operation is the difficulty of closing the crural ring. A vertical incision is made over the hernia and the sac isolated ; it is then opened and examined, and the neck tied high up. Further treatment may then be adopted by sewing together the iliac and pubic parts of the fascia lata, and thus closing the saphenous opening ; or the pectineus may be detached from its pubic origin and sewn to Poupart's ligament ; or the latter may be fixed to the pubic bone by means of staples. Another method is to expose the neck of the sac by a small incision through the external oblique aponeurosis, above Poupart's ligament, to bring the sac through this opening, and there to occlude the neck and affix by sutures. It is now thought by many that no useful end is gained by closing the femoral canal.

Umbilical Hernia.

This may be **congenital,** in which the hernia protrudes into the base of the umbilical cord. The intestine may be tied and cut at the time of birth. It may be **infantile,** in which the hernia comes through a stretched umbilical cicatrix, contained in a preformed sac. This form may be cured spontaneously or may be treated by pressure with a pad and bandage. It may be **acquired,** in which the hernia projects through the linea alba, either above or below the umbilicus. It usually occurs in stout women. The sac is very thin,

PLATE LXV.



UMBILICAL HERNIA.

The sac, containing the intestine without omentum, had not been strangulated.

(Museum, Queen's University of Belfast.)

[To face page 572.

and is derived from a congenital diverticulum. Its contents usually comprise part of the transverse colon and omentum. A good deal of fat is usually present outside the sac wall and in the omentum.

Treatment.—This may be carried out by means of a binder, by a truss, or by operation. For the radical cure an incision is made in a vertical direction, and the sac defined and opened ; the adhesions are then separated, the omentum removed, the sac tied and cut away. The posterior margins of the sheaths of the recti should be sewn together, then the muscles, and lastly the anterior sheaths.

When the hernia is very large, transverse semilunar incisions are preferable, the sac is opened near the margin of the aperture through the abdominal wall, and the hernia reduced ; the sac is cut away, and the upper edge of the opening is brought down to overlap the lower edge, and sewn up in a transverse direction. The recti cannot usually be approximated. The patient should lie in a recumbent position for about four weeks, and afterwards wear a firm abdominal bandage.

Ventral Hernia.

By this is meant any protrusion through the anterior abdominal wall which has not already been referred to.

Hernia in the Linea Alba.—This is usually met with an inch or two above the umbilicus, when it is referred to as **epigastric.** It is as a rule a small painful protrusion of subserous fat. It is treated by removal of the fat and stitching up the linea alba. There may, however, be a process of peritoneum dragged through with the fat, and this may become the sac of a hernia, in which case the operation will be similar to that for umbilical hernia.

The hernial protrusion may occur in the middle line below the umbilicus. It usually occurs after parturition, and tends to spontaneous recovery, when supported by a truss. In bad cases it may be necessary to operate, when the recti are sewn together.

Divarication of Recti.—This is sometimes met with in young children, and consists of a separation of the recti above the umbilicus. This condition usually cures itself.

Hernia in the Linea Semilunaris.—The usual situation is between the deep epigastric artery and the outer edge of the rectus muscle, the hernia entering the lower part of the inguinal canal. This has already been described as direct inguinal hernia, and there is no need to make a separate heading for it. A hernia may also come through the semilunar line above the deep epigastric artery, and it may be observed in the neighbourhood of the semilunar fold of Douglas. It may form no swelling on the outside of the abdominal wall.

Traumatic Ventral Hernia. — Hernial protrusions may occur at cicatrices of the abdominal wall, following operation wounds. They are most usually met with below the umbilicus, in which primary union has not taken place. The condition may be due to suppuration in the wound or to imperfect suturing. It forms a swelling which appears when the patient gets up, coughs, or strains, and may be attended by gastric and intestinal disturbance. The treatment consists in closing the aperture in the abdominal muscles or wearing a belt made to fit the part.

The following forms of hernia are also met with : **Lumbar,** in the space between the last rib and crest of the ilium ; **Obturator,** which

occurs at the opening in the upper part of the thyroid foramen, and appears on the surface at the upper and inner third of the thigh; **Diaphragmatic,** which has already been referred to.

Cystocele.—This is a hernia of the urinary bladder occurring in children and adults, usually in relation to inguinal hernia. Its chief danger lies in the fact that the bladder wall may be mistaken for the sac. Its presence should be suspected when there appears to be a second sac to the inner side of the first one, when there is a large amount of extra peritoneal fat, and the muscular fibres are recognized. **Vaginal cystocele** is a protrusion of the bladder into the vagina; **rectal cystocele** is a protrusion of the bladder into the rectum.

PATHOLOGICAL CLINICAL CONDITIONS OF HERNIÆ.

Irreducibility.—In this condition the hernia is not capable of being reduced, owing to (1) adhesions of the contents to the sac wall; (2) adhesions between the contents of the sac; (3) adhesions between the walls of the sac; (4) the presence of omentum in the sac, in which adhesions readily take place, and where a large accumulation of fat, or cysts may form. It may be present in any form of hernia, most frequently in the umbilical, least frequently in the inguinal. The dangers of the condition are obstruction to the lumen of the intestine and strangulation of its walls.

Treatment.—By operation to reduce the hernia and close the abdominal opening. If operation is refused or contra-indicated, the patient should be confined to bed, an icebag applied to the part for a short time, followed by pressure by a pad of wool and bandages. Subsequently the hernia may be supported indefinitely by a truss.

Inflammation.—This is a condition which may be set up by trauma or by taxis, and involves the sac and its contents. It may also occur as the result of bacterial infection from within, or of strangulation. There are the usual signs of inflammation. The hernia becomes irreducible owing to adhesions, and there is some vomiting and constipation. The condition may lead to abscess formation or strangulation. The treatment consists of rest in bed, the application of fomentations, liberation of pus should suppuration occur, and, later on, radical operation as soon as the inflammation subsides.

Obstruction, or Incarceration.—This usually occurs in fat women suffering from irreducible umbilical hernia, and is usually caused by the presence of solid matter in the loop of gut involved. The hernia is swollen and tender, pain is present, and vomiting takes place. It is a grave condition, and if overlooked may result in strangulation. The treatment consists in putting the patient to bed, emptying the bowel by an enema, and subsequently gentle taxis should be applied to the hernia. If the condition is not relieved by these methods, resort must be had to operation.

Strangulation.—By this is understood the constriction of the contents of a hernial sac to such an extent as to impede the circulation through them. It results from the existence of a tight band or constriction, which is frequently the neck of the sac itself in inguinal

hernia, Gimbernat's ligament in femoral, and in either adhesion of bands within the sac. It may also be caused by the forcing down of a further piece of intestine or omentum through the neck of the sac, or by adhesions and kinking of coils of intestines following inflammation.

Pathology.—In the early stages there is some obstruction of the circulation, with venous engorgement of the intestines, which become dark red or purple ; œdema causes thickening of the walls, while the lumen is distended with gas ; the peritoneum is smooth and shiny, and ecchymoses may occur on the walls of the gut, while bacteria escape through them. Thrombosis follows later on, and the peritoneum becomes covered with a plastic exudate and entirely loses its lustre. The colour of the gut becomes dark purple, and the vessels cannot be emptied by pressure. Bacteria multiply, and pass through the wall in large numbers. If the condition be unrelieved, gangrene will occur, the gut become grey or black in colour, friable in consistence, and perforation may readily take place.

At the point of strangulation ulceration usually occurs from the outside, and bacteria escape by this route ; while above the strangulation distension of the gut occurs, and paralysis of its functions and peritonitis will take place if the condition is not relieved. If the omentum be included in the sac, it will undergo similar changes, but is less liable to gangrene. The sac itself is the seat of peritonitis. There is inflammation, with copious exudation, which becomes blood-stained. Plastic lymph may be deposited on its surface, and sloughing takes place owing to bacterial action. The sac will finally burst, giving rise to a fæcal fistula.

Signs and Symptoms.—The hernial protrusion becomes hard and irreducible, later on tender and painful. There is often a history of a recent enlargement, and there is no impulse on coughing. After a time the skin over the hernia becomes inflamed and of a dark colour, while over the abdomen there is severe pain, referred to the umbilicus ; later on it becomes tender and rigid. Distension and tympanites are present, and the ordinary signs of peritonitis develop. Shock is usually marked, especially in enterocele, Richter's hernia, and in cases where strangulation occurs at once. The pulse is at first slow and somewhat weak, and later becomes rapid and irregular. The temperature may be subnormal at first, but rises on the onset of inflammation. The pain, which is at first referred to the umbilicus, is later felt over the region of the hernia, and occurs as colic following constant abdominal pain. It diminishes on the onset of gangrene. Vomiting is a marked and valuable sign ; it consists at first of food, later of bile, and later still of stercoraceous fluid. Constipation is usually absolute, arising from obstruction, paralysis, and peritonitis, but it may not be present at first when the strangulation occurs high up, or not present at all in cases of epiplocele or where the contents of the sac are other than intestinal. Toxæmia occurs after the strangulation has lasted for some time, and is indicated by a shrunken and anxious facies, a subnormal temperature, unconsciousness, delirium, and coma. When the hernia is an old-standing one occurring in an elderly patient, shock may be almost or entirely absent, local tenderness, constipation, and slight vomiting, representing the symptoms. In such cases, when gangrene occurs there is relief of abdominal pain and of tension and tenderness over the hernia, and there may be some slight œdema.

Treatment—*Taxis.*—By this is understood the manipulation of the gut back into its place. It is a procedure which has largely fallen into disrepute, unless when operation is contra-indicated or refused. The foot of the bed should be raised, and the patient placed in a position that will relax the parts at the site of the obstruction. The neck of the hernia is then held steady with one hand, while with the other the protrusion is gently squeezed, to make the contents, if possible, pass back into the abdomen. No force should be used, and the attempt not continued unless accompanied by gradual diminution in the size of the hernia. The disappearance of the protrusion should be tested by passing the finger into the hernial canal. The dangers of the proceeding are that the bowel may be further injured, or the hernia only **apparently** reduced. Of this accident there are several kinds : (1) Rupture of the sac near the neck, and escape of its contents into the extraperitoneal cellular tissue. (2) Reduction into another sac. This usually occurs only where there is another sac united to the first by a common neck, the bowel being forced by the manipulation from one into the other. (3) Reduction of the hernia *en masse*, usually the result of continuing taxis for too long a time and without proper observation. The whole sac is thus forced inside the abdominal wall, without the relationship of sac and contents being altered. It naturally follows that in all these cases the symptoms of strangulation continue. When this accident occurs, operation must be proceeded with to relieve the condition.

Operative Treatment.—Operation should in most cases be undertaken for strangulated hernia without delay, the danger of which is sepsis, paralysis or gangrene of the gut, and the increase of general constitutional symptoms.

The operation is preceded by washing out the stomach when vomiting is severe. The contents of the hernia are then exposed by cutting down on the sac, which is carefully opened and all contained fluid let out. The seat of strangulation is then sought for; it is usually found at the neck of the sac and divided. In cases of oblique inguinal hernia the incision is made outwards at the neck of the sac, in femoral hernia inwards ; in all others the strangulation should be relieved, whenever found, by the smallest possible incision. The contents should then be examined as to the state of vitality of the gut or other viscus. If viable, the peritoneum is smooth and shining, and the vessels can be emptied ; if not viable, the peritoneum is lustreless, it may be covered by lymph ; the colour of the gut is deep purple or grey, and the vessels cannot be emptied on pressure. If found viable, the gut is returned to the abdomen ; if not, the defective portion should be resected. If there be a small ulcer or gangrenous spot on the wall of a gut which is viable, it may be invaginated, and the healthy wall sewn over. Any redundant omentum should be ligatured and removed. The radical cure should be performed at the same time, unless the patient's condition is very serious from gangrene or sepsis; when these conditions are present a drain should be passed through the wall of the abdomen.

After-treatment consists in giving turpentine and soap enemata till the proper functions of the bowel are restored, while saline infusion by the rectum may be given to combat shock. It is well to avoid stomach feeding until the bowels have been naturally moved.

Complications.—Intestinal obstruction may result from paralysis of the gut. Peritonitis may be set up. Acute enteritis, with passage of blood and mucus, may result.

CHAPTER XXVIII

THE RECTUM AND ANUS

Congenital malformations — Proctitis — Foreign bodies — Ischio-rectal abscess — Fistula in ano—Stricture of the rectum—Syphilitic disease—Tumours: simple, malignant—Hæmorrhoids—Prolapse—Pruritus ani—Incontinence of fæces.

Congenital Malformations — Developmental Errors. — Absence of the rectum and anus ; the colon ends at the pelvic brim ; there is no bulging in the perineum at the site of the position of the anus when the child cries. In this condition it is usually necessary to perform an initial inguinal colostomy, unless the rudimentary rectum can be reached from the perineum, and subsequently to make an opening for the end of the colon in the perineum.

The rectum may be present but the anus absent ; in this case bulging occurs in the perineum when the child cries. It is usually sufficient to make an incision in the middle line in an outward direction, bringing the rectum down and sewing it to the skin.

The anus and its canal may be present, but not continuous with the rectum, being shut off from it by a septum. It is possible to feel the dividing line, usually situated about an inch above the anus. For this condition the usual treatment is to divide the septum and dilate the canal to the normal size.

A congenital stricture may exist, usually at the junction of the anal canal and the rectum. This requires to be dilated by the passage of bougies, gradually increasing the size at successive sittings until the normal width of the canal has been reached.

The rectum sometimes communicates with the bladder, vagina, urethra, or vulva. The usual treatment for such conditions is to perform a permanent colostomy, if there is not free passage for the fæces, and subsequently, by means of a plastic operation, to close the opening in both organs.

Proctitis.—This is an inflammation due to infection of the rectum, which is predisposed to by the presence of foreign bodies, such as fish bones or other articles which may have been swallowed, or it may result from persistent constipation causing irritation by means of hardened fæces. Other causes of the condition are a tumour of the rectum, piles or fissure, prolapse, and various constitutional diseases, such as dysentery, syphilis, tubercle, and gonorrhœa. The rectum is frequently infected in common with the colon. In children a usual cause is threadworms, and the bilharzia in those who have lived in Africa.

Symptoms.—There is painful tenesmus and a bearing-down pain, with a feeling of weight and fulness in the perineum, while pus or muco-pus mixed with blood is discharged from the anus. The anal

mucous membrane is hot, and the skin around the anal margin excoriated. Reflex irritation of the bladder gives rise to increased frequency of micturition.

Treatment.—The treatment will a good deal depend upon the cause of the disease. As soon as this is ascertained, it should be removed if possible. For washing out the rectum large hot-water enemata should be used, and for the relief of pain and tenesmus lead and opium lotion or morphine suppositories. In the later stage, protargol (one grain to the ounce) is useful. If the condition is due to threadworms a suitable purge and an injection of infusion of quassia may cure it. In the form caused by the bilharzia, the polypi, which usually contain the eggs of the organism, should be scraped away.

Periproctitis.—This is a cellulitis of the connective tissue round the rectum, and may arise from a spread of infection from the bowel, or it may commence in the tissue itself. It usually gives rise to perirectal abscess.

Foreign Bodies.—These may become impacted in the rectum, giving rise to symptoms of obstruction, or they may injure the wall, and cause inflammation and septic conditions. The foreign body may find its way to the rectum by being swallowed and passing along the digestive tract ; those usually met with from this source are tooth-plates, bones, pins, buttons, etc. They may form in the alimentary canal or in the glands opening into it ; such are enteroliths and gall-stones. Again, the foreign body may be introduced through the anus, and may be of any conceivable form. When the body lodges in the rectum, there is usually constipation and discomfort, with a desire to evacuate the bowel; tenesmus is often present ; the efforts to empty the bowel result only in the passage of some mucus or blood. If the body press upon the bladder, it may give rise to frequent desire for micturition and if pressing upon the cords of the sacral plexus it will cause shooting pains in the lower limbs. Ulceration of the wall of the rectum very often takes place, giving rise to a muco-purulent discharge, and foreign bodies may be the cause of a submucous or perirectal abscess. Digital examination of the rectum may reveal the presence and the form of the body ; if not, a speculum should be used, and the X rays may be utilized to locate and differentiate a body which proves difficult to examine.

Treatment.—Small bodies may be removed by cocainizing the mucous membrane and inserting a small amount of ointment, when they may be removed by the finger or come away of themselves ; if a large body is present, and especially if impacted against the mucous membrane, general anæsthesia is necessary, and special care should be taken, when moving the object, that the wall of the bowel is not injured. It may be necessary in some cases to open the anal canal by cutting backwards in the direction of the coccyx before the object can be removed.

Ischio-Rectal Abscess.—The anatomy of the fossa should be remembered. It is of triangular shape, the outer wall being formed by the ischium and the obturator internus, covered by its aponeurosis ; the inner wall by the rectum and levator ani muscle ; the base by the skin ; the apex by the junction of the aponeurosis of the obturator internus and levator ani muscles ; in front is the triangular ligament, and behind the edge of the gluteus maximus.

Infection is common in this space owing to the low bacterial resistance of the fat which forms its chief contents. It may occur through the rectum by ulceration or perforation ; from outside by a wound or abrasion of the skin ; from pelvic disease through the outer wall, or possibly from the urethra in front. Owing to infection from one of these sources cellulitis may be set up, and gangrene may supervene in old people with low vitality. More usually acute ischio-rectal abscess results. When the abscess is chronic it is usually of tuberculous origin.

Symptoms.—There is local inflammation, a hard swelling in the perineum, and a tumour which is hot and exceedingly painful can be

Fig. 106.—Multiple Fistulæ in Ano.
(Stewart's "Surgery.")

felt *per rectum ;* defæcation is painful and difficult, and there is a good deal of general constitutional disturbance. The abscess may burst into the rectum, on to the surface or in both directions ; in the latter case a complete fistula (fistula in ano) results, the interior opening being into the rectum above the sphincter, and the outer one on the skin near the anal margin.

Treatment.—In acute cases the abscess should be opened from the perineum and drained ; if an opening is found into the bowel, the rectal wall and sphincter should be cut through. In chronic cases the abscess should be emptied, scraped, and the cavity packed with iodoform gauze. Owing to the situation there is great liability to septic soiling, and the condition is very difficult to cure ; in certain cases colostomy may have to be performed before this takes place.

Fistula in Ano.—This results from some inflammatory condition of the bowel setting up ulceration or perforation, and is also secondary to ischio-rectal abscess. It may also be caused by ulceration due to tuberculosis, syphilis or malignant disease.

The nomenclature is confusing, since many of the conditions described as fistulæ are really sinuses. Three varieties are described: (1) **Complete**, in which there is an opening into the rectum internally, and on the skin frequently one or two openings about an inch from the anus. The internal opening is generally single and met with in the space between the sphincters or above the internal sphincter. (2) The **blind external fistula**, more correctly called an "external rectal sinus," opens on the skin surface, but not into the rectum. (3) The **blind internal fistula**, more correctly called an "internal rectal sinus," opens into the rectum, but not on to the skin. It must be understood that one of these types may change to another.

A suppurating sinus communicates with one or both of the openings. It may run outside the bowel; it may perforate it obliquely, and thus run for some distance between the mucous membrane and the muscular coat; or it may encircle the bowel, especially after the bursting of a so-called "horseshoe" or bilateral ischio-rectal abscess, and it may then open on both sides, forming a "horseshoe" fistula; burrowing is usually most marked on the posterior aspect of the rectum. When much burrowing occurs, the internal opening is found, not between the sphincters, but above the internal one. If the case becomes chronic, there may be great thickening of the tissue around the sinus, and diverticula frequently open off in various directions.

Symptoms.—There is pain, especially during defæcation, except in the blind external fistula, in which it is not marked. A purulent discharge comes from the sinus or from the anus, or from both. In the case of the blind external fistula, after the symptoms which are referred to the abscess subside, there may be a small discharge of thin sero-pus from the sinus; if the opening closes up, as it sometimes does, the discharge is retained for a few days, and then bursts out again, or a secondary abscess may be formed. In the blind internal fistula the internal sinus frequently closes up and reopens.

Treatment.—As a preliminary, saline aperients may be given for a couple of days. An opium pill a few hours before the operation, and a glycerine enema just previous to it. The only satisfactory treatment is to lay open the whole track, together with its burrowings, when it may be thoroughly disinfected and allowed to heal from the bottom.

In a *complete fistula* a probe should be passed along the entire length of the track; a finger is then introduced into the rectum and the end of the probe felt for, bent round, and brought out at the anus; a curved probe-pointed bistoury is then passed down the track and the tissue between the probe and the surface is cut through. The walls should then be scraped and the wound packed with iodoform gauze. To prevent septic changes, the dressing should be renewed daily. Care must be taken to pack the sinus carefully each time to the bottom. Occasionally it may be possible to hasten healing by bringing the deep parts into position by sutures, provided that the part has been rendered aseptic. The internal sphincter should not be cut if it can be avoided, in order to avoid the risk of incontinence.

A *blind external fistula*, when it is situated superficial to the internal sphincter, should be converted into a complete fistula by forcing a probe through the mucous membrane at its upper end, and the track treated as above; if the sinus pass deeply into the ischio-rectal space, so as to be above the internal sphincter, it should not then be converted into a complete fistula, but treated by enlarging the external opening, disinfecting the sinus, and packing it.

A *blind internal fistula*, if it is submucous and below the internal sphincter, should be rendered complete by passing a probe from the rectum and cutting the intervening tissue ; but if the opening is above the internal sphincter it is well to try and preserve the muscle, and bring about cure by making a complete fistula, but not dividing the intervening tissues ; the external part of the fistula is then opened up and packed, when the internal opening may close.

When a fistula is due to *tuberculous* disease, it is usually the complete form that is met with, but it differs from the septic type in being placed towards the anterior rather than the posterior part of the rectum, in being markedly indurated with the discharge of a thin character, and in being painless, while the external opening is irregular and the surrounding skin unhealthy. The treatment is the same as for other fistulæ.

Fistulæ may exist between the *rectum and other organs*, the most common being that between the rectum and vagina (*recto-vaginal fistula*), usually resulting from rupture of the perineum or from pressure during parturition producing sloughing of the septum. Fæces escape by the vagina and set up irritation, and, on examination by the finger, both openings can be felt, or they may be seen through a speculum. The edges should be pared and the septum re-formed ; it is sometimes necessary to excise the whole track. A fistula is also met with between the rectum and urethra (*recto-urethral fistula*); it may result from injury or the spread of malignant disease. The urine generally passes into the rectum. Examination of the opening may be made through the rectum, and is usually found above the internal sphincter. Various plastic operations have been suggested for the condition; it is probably best to perform temporary inguinal colostomy, and subsequently to drain the bladder by suction, and allow the fistulous opening to heal. An opening usually secondary to cancer of the rectum may occur between the rectum and the bladder (*recto-vesical fistula*). The treatment is that for the primary condition.

Fissure in Ano.—This is really an ulcer of the anal margin, situated usually in the mid-posterior line. It is common to find what is called a " sentinel pile," formed by a tag of skin, placed below the fissure. The ulcer consists of a small tag of mucous membrane which has been torn off by a hard fæcal mass, and by subsequent soiling and pressure forms an ulcer. The condition is met with in men and women in about equal proportion.

Symptoms.—The fissure is met with in adult life ; if it occurs in childhood, it is probably due to hereditary syphilis. The characteristic symptom is severe and burning pain during and after defæcation, accompanied by marked tenesmus. The fæces are frequently tinged with blood ; in the early stages the pain is more acute in character, in the later more burning and accompanied by spasm of the sphincter, which may last for an hour or two after defæcation. On examination the anus is found drawn in, in order to protect the painful part, when the buttocks are separated ; it is wise to examine the rectum also in order to find if there is any other pathological condition present.

Treatment.—Large hot enemata may be given, together with laxatives, cocaine suppositories passed in after defæcation, and the diet regulated ; these methods will be of no use unless the case is a very slight and early one. For the more pronounced cases an anæsthetic should be given, the " sentinel pile " snipped away, and the

edges of the fissure and the base of the ulcer scraped ; or the entire ulcer may be excised, carrying the incision through the sphincter muscle, so as to paralyze it for a time, so allowing the wound to heal soundly.

Stricture of the Rectum.—This may result from simple ulceration, syphilis, tubercle, or cancer.

The non-malignant cicatricial form is most common following dysenteric, gonorrhœal, syphilitic, or tuberculous ulceration. It may also follow cellulitis of the peri-rectal tissue which contracts the outside of the gut, and occasionally it may follow piles. It is usually met with in adult women.

The stricture is situated two or three inches above the anus ; it may be annular and smooth, broad and irregular, or adherent to the sacrum. The gut above the stricture is usually hypertrophied, is probably dilated, and may be ulcerated ; below the stricture the gut, widely dilated, being thus an exception to the usual rule in stricture of the intestine.

Symptoms.—There are usually alternating attacks of diarrhœa and constipation, with attenuated stools and passage of blood and mucus. There may be signs of chronic intestinal obstruction, while ischio-rectal and pelvic abscesses may result owing to rupture following impaction above the stricture, or to infection passing through the gut wall. Chronic fistulæ in the buttock may result from the formation of fæcal abscess.

Treatment.—This consists of dilating the stricture when it is of fibrous origin due to non-malignant cause. Division of the stricture at one or more points from within may be practised in low strictures, and complete posterior division of stricture and sphincters from without in long strictures. The stricture may be excised when the passage of bougies cannot be tolerated, and when the tissue involved is short and the bowel otherwise healthy. When due to malignant disease, the tumour must be removed when possible. In some cases of stricture it is necessary to make an artificial anus in the inguinal region or at the sacrum as a preliminary to operation.

Syphilitic Disease.—A primary chancre is not common at the anus, but is occasionally met with ; its treatment does not differ from that of chancre elsewhere.

Condylomata are commonly met with around the anus in the secondary stage of the disease.

Gummata as tertiary manifestations begin in the submucous coat of the rectum, and may give rise to stricture. They produce an infiltration of the wall ; ulceration usually follows, involving a considerable depth of tissue, but a diagnostic negative symptom of the cause of the condition is its comparative painlessness. The ulceration may extend downwards to the anus or upwards to the sigmoid flexure, while it may involve the vagina or the bladder, and give rise to a fistulous opening in these organs or on the surface at the perineum.

The condition is most usually met with in women.

Symptoms.—There is some pain and tenesmus, with a discharge of blood and pus and later, the signs of chronic obstruction and stricture.

Treatment.—Iodide of potash and perchloride of mercury should be given, and continued till all active symptoms of disease abate. It

PLATE LXVI.

CARCINOMA OF RECTUM.

The darker area is the tumour proper, while the surrounding part is indurated.

(Museum, Queen's University of Belfast.)

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may be necessary to perform colostomy as a temporary or permanent procedure.

TUMOURS OF THE RECTUM.

Innocent—Polypus.—This usually consists of gland tissue and connective tissue, and is attached to the submucous coat by a pedicle. The condition is most frequently met with in children, and may give rise to rectal pain and tenesmus, and sometimes may cause prolapse of the bowel, or the growth itself may protrude through the anus. It should be removed after applying a ligature to the pedicle.

A polypoid growth of the mucous membrane sometimes occurs which is due to the bilharzia.

Papilloma.—This may occur as a local or as a diffuse growth. There is great tendency to free hæmorrhage. It is a rare condition, and should be treated by removal.

Malignant.—Malignant growths of the rectum are epithelioma, sarcoma, and carcinoma. The latter is much the most common.

Epithelioma.—This usually attacks the anus, frequently at the site of an old fissure. It may occur as a hard, wart-like growth, but ulceration soon occurs. The edges are hard and everted, and the surrounding tissue indurated. It bleeds very easily, and there is a foul discharge. The inguinal glands are found enlarged at an early date. The growth should be freely removed, together with any enlarged glands.

Sarcoma is rare. When present, it usually occurs in young patients, and forms a diffuse growth in the submucous tissue, and probably leads to symptoms of obstruction. Ulceration is rare, and, if occurring, does so late in the disease. The growth should be removed.

Carcinoma.—This is slightly more common in men than in women. It usually appears after middle life.

The growth begins in the glands of the mucous membrane, and spreads up and down the gut, into its lumen, and through the wall, to involve neighbouring structures.

It may occur as an ulcer, the disease having eroded the mucous membrane, with hard raised edge, which grows in a singular crateriform manner; or as a large fungating mass which projects into the bowel. The disease may result in a fibrous annular stricture, or possibly may take this form from the beginning, by growing between the mucous and muscular coats in this form, when there is little new growth or ulceration.

The columnar-celled carcinoma is the variety met with. It may show colloid degeneration, especially in young patients. When the glandular element predominates, the growth is soft and grows rapidly; when the fibrous, the growth is hard and likely to form a stricture.

When extension occurs, the growth may involve the sacrum, the cellular tissue, or the pelvic vessels and nerves, and may extend to and involve the vagina, uterus, prostate, or bladder. At first the fixation of the rectum is due to contraction of fibrous tissue, but later the growth invades surrounding structures. Fistulous openings may occur into the vagina or bladder as a result of ulceration. Extension by metastasis is unusual, and, when occurring, is late in the disease. It is found in the lumbar glands, or in the inguinal when the anus is involved, and in the liver, peritoneum, and lungs.

Symptoms.—There are few early symptoms before any obstruction has taken place. The first one to attract the attention of the patient is constipation. There may be pain and tenesmus, bleeding at the time of and after a motion, which is offensive. Blood-stained mucus may pass frequently, or only at the time of the motion. Diarrhœa is usually present, alternating with constipation. If the rectum be examined, the tumour may be felt either as a hard ulcerated surface or as a soft fungating mass, which as a rule is not fixed.

Later on there are signs of obstruction of a chronic type in addition to the symptoms already given, and as well there is abdominal distension with visible peristalsis. Pain and tenesmus are more common now than in earlier stages, in which they may be absent. When the neighbouring structures become involved, there is severe constant pain of a neuralgic type, usually caused by involvement of the sacral nerves. Morning diarrhœa, followed by a normal motion, but leaving the rectum with the feeling that it has not been emptied, is a typical symptom. There is œdema, owing to the involvement of the vessels. Gas or fæces may be passed through the urethra or vagina owing to ulceration of the bladder or vaginal wall. The kidneys may be affected by hydro- or pyonephrosis owing to blocking of the ureters, and uræmia may result. An abscess may form almost anywhere in the pelvis, or in the ischio-rectal fossa, and is frequently associated with fistulæ. On examination now, it is found that the growth is fixed; the bowel does not move on straining. Cachexia occurs in the late periods of the disease, and is associated with secondary growths. Frequently the patient does not reach this stage, but is carried off at an earlier one by obstruction or septic poisoning.

The disease varies much in its duration. When the growth is soft and grows in comparatively young patients, the course is usually rapid and fatal; in older patients with a hard growth, the condition is more or less chronic, and they may live for years.

Diagnosis.—In the early stages it is difficult to distinguish cancer from internal piles, polypus, etc., except by careful rectal examination, when it is found that, in the case of **piles,** there is no actual growth, but rather swollen, irregular lines, though it should be remembered that piles may develop with cancer. If the symptoms are due to **fissure,** the pain is more severe in the early stage, and the ulcer and "sentinel pile" can be recognized. When a **polypus** causes the symptoms, the growth is small and pedunculated, and the surrounding mucous membrane is healthy. In a non-malignant fibrous stricture there is no new growth, and the parts are not actively inflamed. Any bleeding that may occur is slight. When **gummata** give rise to signs suggestive of malignant disease, examination will show that they are soft and non-vascular, they give little pain, while the ulcer itself is rather irregular, undermined, and not indurated.

Treatment.—If possible, the growth should be removed. This is undertaken when it is not fixed and there is no secondary deposit or marked debility.

The perineal excision is practised when the growth is low down and within reach of the finger. The anus is in this operation excised, with the lower part of the bowel, and the wound is plugged round a tube either with or without anchoring stitches being inserted in the gut and skin.

When the growth is too high for this method, and the sphincter of the anus can be preserved, a high operation is to be performed,

preceded by preliminary colostomy. In this operation (trans-sacral, Kraski method) the coccyx is removed, and an incision made over the sacrum, the lower part of which is removed, below the third vertebra in order to avoid implicating the sacral plexus. The bowel is then isolated and removed, together with any surrounding tissue which is involved, and the ends of the bowel above and below are united.

The abdomino-perineal route is substituted when the growth extends above the third sacral vertebra. If possible, the colon is brought down and united to the anus. This part of the operation is done from the perineum.

Many cases are not found suitable for operation, owing to extension and involvement of various neighbouring organs, the sacrum or the glands and cellular tissue, or on account of the general condition of the patient, and operation is of course contra-indicated after metastasis has occurred. The treatment in these cases will be palliative. It consists of giving soft food leaving little residuum, washing out the bowel daily by means of a soft tube, and, when obstruction occurs, the performance of colostomy.

Mortality of Excision.—Zinner gives the mortality following excision for cancer of the rectum at 15 per cent. immediately after the operation, 25 per cent. of the cases surviving for three years or upwards ; while in about two-thirds of all cases, when recurrence takes place, it does so within the first two years. Prognosis is rendered bad when the anus is involved. Such cases as a rule do not survive for three years. The site of recurrence in most cases—about 72 per cent.—is local, while in about 24 per cent. recurrence is in the form of visceral involvement, and in 4 per cent. in the lymphatic glands. The average length of life after recurrence is about two years.

Hæmorrhoids.—Hæmorrhoids, or piles, are varicose and hypertrophied veins of the anal region and the lower part of the rectum. Two general varieties are described—internal piles, which begin in the upper part of the anal canal; and external piles, which occur in that part of the canal which is lined with skin. Piles are sometimes referred to as " mixed," which indicates the presence of both types. Marginal piles were formerly described as a division occurring half in and half outside the anal margin. These are seldom met with. Piles may occur at any period of life, but are seldom met with before puberty. Both sexes are about equally affected, except in the case of pregnancy, when they are common.

The **Causes** of the condition are various; probably the most important and common one is chronic constipation. Other causes are the continued straining which is caused by such conditions as enlarged prostate, stricture of the urethra, and vesical calculus. Increased backward pressure in the venous circulation, such as results from heart disease or cirrhosis of the liver, and pressure caused by an intra-abdominal tumour, may contribute to the condition. It is predisposed to by the arrangement of the venous system, from the anastomosis which exists between the portal and the systemic circulation occurring between the superior, middle, and inferior hæmorrhoidal veins, and by the absence of any valves in the portal vein.

External Piles.—These are covered by skin ; they are associated with a varicose condition of the branches of the inferior hæmorrhoidal vessels, which result in dilatation of the veins around the anal orifice.

The pile consists of a central vein which is covered by a tag of hypertrophied skin.

The **Symptoms** are as a rule slight, and consist chiefly of itching and pain ; but considerable disturbance may be caused by scratching of the part to relieve the pruritus, eczema may thus be caused, or septic conditions by an abrasion of the surface ; while thrombosis and suppuration may follow, and enlargement of the inguinal glands occur.

The **Treatment** of the condition in many cases is extremely simple, and consists of keeping the parts cleansed and the bowels regular, and snipping off piles if they continue to cause trouble. This, however, must be done with economy of tissue lest excessive cicatrization may result. Occasionally the pruritus, either with or without removal of the piles, continues to cause inconvenience and trouble; the best treatment for this, when it persists, is bathing with a lotion containing 20 grains of sulphate of iron to 4 ounces of Listerine, and, after drying the parts, dusting freely with emol keleet.

Occasionally there is a fold of perineal skin which simulates a pile, and has been called a " connective-tissue external pile." It is not, strictly speaking, a pile, since it does not contain any varicose vein. This swelling may cause the symptoms referred to above, and is treated in the same way.

Internal Piles.—These are a very common and important variety of hæmorrhoids. They occur inside the sphincter, and may extend for an inch or two up the rectum. Each pile consists of a central arterial twig which is surrounded by varicose sacculated veins and a certain amount of connective tissue. They form an elongated spindle-shape swelling which is covered by mucous membrane ; one only may be present, but as a rule they are multiple. They form a series of purple-coloured fleshy masses inside the anus, and are of different consistency, some being thick and firm, others thin-walled and easily made to bleed. Following septic infection, phlebitis, thrombosis, and periphlebitis, may be set up ; while phleboliths sometimes occur within the thrombosed veins. If suppuration arises, it may cause portal pyæmia. Internal piles may give rise to prolapse of the rectum or to fissure of the anus.

Symptoms.—Pain, which may be constant, but is especially present after defæcation ; bleeding, which occurs at the same time or may be almost constant ; a discharge of mucus, and a tendency to prolapse of the mucous membrane of the rectum.

In the early stages the piles remain inside the anus and are not protruded by straining ; the veins are in a varicose condition, but do not form distinct tumours. The bleeding is usually slight, and perhaps only amounts to a streaking of the motion with blood. Later on the vessels become dilated, and sacculation occurs, purple-coloured fleshy tumours being formed, which are protruded by straining, but return or can be easily returned by the patient. Bleeding now becomes a more prominent symptom, and blood escapes from the piles after they have come through the anus, and continues to flow so long as they remain down ; it is due to the interference with the venous return by constriction of the neck of the pile by the external sphincter ; it ceases when the piles are returned within the bowel. Occasionally the blood is arterial in character, usually due to ulceration having eaten through the wall of the small artery of the pile ; bleeding in this case may continue even after the piles have been returned. The blood

collects in the rectum, and is passed at the next defæcation or some time before it, and the loss produces serious constitutional symptoms.

Still later the piles remain down, and can only be returned with difficulty, or sometimes not at all. This is the type of pile which usually leads to prolapse of the bowel. There is not much bleeding at this stage, owing to the mucous membrane becoming hardened and thickened.

Diagnosis.—On examination, the skin around the anus is usually found loose, with the normal folds exaggerated. When the disease is of old standing, the sphincters may be lax and the pile mass brought into view by very slight straining. If a fissure complicates the case, the sphincter is tightly constricted, and the piles cannot be brought down even upon straining. On passing the finger into the rectum, the masses of piles may be felt in advanced cases, but in early or comparatively early cases the condition may be scarcely recognizable, the examining finger only feeling ridges on the mucous membranes near the anal orifice. The marginal pile, if present, is covered half by skin and half by mucous membrane, but partakes somewhat of the character of both varieties. It is common for external piles to exist in conjunction with internal piles. On examination with a speculum, the piles can be detected even in early cases. When nothing can be made out to account for the symptoms, the proctoscope may be used to examine the upper part of the rectum.

Treatment.—In the early stages palliative measures should be adopted. These consist in relieving constipation and promoting the action of the lower bowel by suitable drugs, especially the extract of cascara sagrada, which is better taken in the liquid form mixed with equal parts of glycerine. All drastic purgatives should be avoided. The patient should have a simple plain diet, with the avoidance of highly spiced dishes, condiments, and alcohol, and should lead a less sedentary life. After defæcation the perineum should be sponged with cold water and dusted with emol keleet. When there is a tendency to eczema or marked pruritus, it is advisable, instead of sponging the part with water, to use a little dry cotton-wool. Various ointments recommended are of little or no use, but a suppository containing morphine and adrenalin is useful to relieve pain and contract the vessels.

The patient may suffer from time to time from "attacks of piles," which induces thrombosis of the veins, and sometimes septic infection results. The pain becomes intense and dragging, both in the perineum and over the sacrum, with a rise of temperature, great depression of spirits, and at times the patient is rather seriously ill, especially in the septic variety, when the glands in the groin are enlarged. For these attacks the patient should be confined in bed, with the buttocks resting on a pillow, morphine suppositories inserted through the anus, and a diet of the simplest character adopted. A little cascara should be given at night, and some Apenta water in the morning. One of these attacks may lead to cure of the condition by thrombosis of the veins or sloughing of the whole mass of the pile. Some advise choosing the time of an attack to give an anæsthetic and remove the piles. It is questionable whether this is a wise proceeding. The better time is an interval when the piles are contracted and no inflammation exists.

Operative Treatment.—Various operations have been proposed and carried out for piles. One of them should be adopted when the

condition persists and the symptoms increase in severity, and in the absence of obstruction of the portal circulation by cirrhosis of the liver, or of heart disease.

Some hours before operation a glycerine enema should be given. This will be found more satisfactory than soap and water before any rectal operation.

Formerly, removal by crushing the pile with a special instrument, or by clamping it and burning it off with a cautery, were methods widely carried out, but have now fallen into disrepute. The two methods now practised are—**Ligature and excision** or **Whitehead's operation.** The former method is the most simple and generally applied. After dilatation of the sphincter to bring the piles into view, each one is caught separately by a pair of forceps, and the mucous membrane at its base snipped through. A silk ligature is then passed round it, and the pile beyond the ligature is cut off. It is better to pass the ligature through the base of the pile and tie a Staffordshire knot, in order to avoid slipping. A. B. Mitchell has modified this operation, and clamps the base of each pile with a pair of Kocher's artery forceps, and after cutting off the distal part of the pile he introduces a purse-string catgut suture to include the clamp and the tissue at the base of the pile. When the suture is ready to be tightened, he removes the clamp; the tightened suture thus arrests the hæmorrhage and closes the wound. Healing is thus rendered more rapid, and no raw surface is left. The bowels can be moved at the third day. This method is sometimes called "excision," as distinct from ligature and removal of the pile.

Whitehead's operation consists in removal of the mucous membrane of the pile-bearing part of the bowel, and uniting the upper healthy mucous membrane with the anal margin. It is a useful operation for advanced or recurring types of the disease, but is accompanied by much bleeding, and may be followed by pelvic inflammation and cicatricial stenosis. After the operation a central rubber tube may be introduced into the rectum.

After all operations for piles a morphia suppository should be introduced, a gauze dressing covered with vaseline applied, and a T-shaped bandage put on. The diet for a few days should consist of fluids, and when the bowels are required to act, a dose of castor oil is administered, followed in the morning by an injection of warm olive oil.

Prolapse of the Rectum.—This may be complete (*procidentia recti*) or incomplete. The former is most common in children, in whom all the coats of the bowel are extruded. The latter is often associated with the presence of hæmorrhoids in adults, and as a rule only the mucous membrane is extruded.

The condition is predisposed to by a relaxation of the tissues of the part, and is excited by straining of the constant type, such as may be produced by enlarged prostate or stricture of the urethra; by chronic constipation and piles; in children presence of worms may be the exciting cause. On examination, a protrusion of the mucous membrane of the anal margin is found, which gradually increases until a conical projection is formed, which may be large or small according to the condition of the parts. In this mass is a central orifice which communicates with the lumen of the bowel, and the walls of the tumour join the skin at the anal margin. There is usually a mucous discharge and some bleeding, with incontinence of fæces, when it is an old-standing condition. Strangulation and sloughing are rare

occurrences, which may, however, take place. The condition has to be diagnosed from piles, polypus, and an intussusception which has come through the anal orifice, the last-named being the only condition with which it is really liable to be mistaken ; a distinction is made by observing that in intussusception the finger is passed into a cul-de-sac between the anal margin and the protrusion, and that the mucous membrane is not continuous with the skin at the anal margin.

Treatment.—This may be palliative or operative. Reduction of the prolapsed mass is first effected by raising the pelvis, and smearing the protruded bowel with vaseline; continued gentle pressure is then applied over the top of the cone-shaped mass, which usually slips back easily in mild, recent cases. All causes of straining or irritation of the rectum should be removed. Defæcation is carried out in a lateral position the last thing at night. Injections of ice-cold water or of a weak solution of sulphate of iron may be used, and a pad of lint soaked in such a lotion is tied on with a T-shaped bandage.

Operative procedure consists in scarifying the mucous membrane in incomplete prolapse, or in removal of a wedge-shaped piece from the posterior aspect when the prolapse is complete. A more radical operation is to excise the whole of the projecting tumour and suture the bowel. Occasionally the sigmoid flexure is sutured to the skin (colopexy) in some relapsing cases. Operation is not usually required in a child, but in the adult it is seldom that a permanent cure can be effected without it.

Pruritus Ani.—By this name is indicated a condition in which there is almost constant and intense itching in the perineum around the anus. It occurs as a symptom of many affections of the rectum, such as worms, hæmorrhoids, and ulceration, and also of certain skin diseases, particularly eczema. Gout and diabetes also give rise to this symptom, and as a rule it disappears upon the cure of the condition causing it. There remains, however, a distinct condition under this name of "pruritus ani" which persists in spite of all palliative treatment, or as an isolated condition for which no cause can be ascertained. It begins with an uneasy feeling and an itchiness about the anus, which gradually increases. Itching, which is at first intermittent, later on becomes constant, and worse at night, preventing sleep, or the patient may violently scratch the part during sleep. The condition may give rise to grave constitutional symptoms. On examination the skin is seen to be excoriated and moist ; it loses its stratified epithelium, and thickened œdematous folds are found radiated from the anal margin.

Treatment.—The local or constitutional cause should be removed ; and if the condition persist in spite of treatment, an operation should be carried out which is based on the suggestion of Ball, that there is a change in the sensory nerves of the part. This consists of dividing the terminations of the nerves of the affected area. A curved incision is made on each side of the anus, leaving a narrow area in front and behind. This incision is carried down as far as the sphincter muscle ; the flaps are then raised from the muscle surface and round the anal margin, and as far up the canal as the muco-cutaneous junction. The uncut skin in front of and behind the outer margin of the incision is then undercut for about a quarter of an inch free of the involved area. The flaps are then replaced and secured with sutures. The results of this procedure have been good.

Incontinence of Fæces.—This may occur as a result of interference with the nerve-supply of the sphincter muscles by injury involving the nerve centre. On examination the sphincters are found relaxed, and a discharge of fæces usually takes place at intervals. It may also be a symptom of stricture of the rectum, colitis, or dysentery, or may be due to direct injury of the muscle itself. If the internal sphincter remains intact, incontinence is not absolute.

The **Treatment** is to remove the cause as far as possible. In direct injury the muscle may be restored by plastic operation.

The incontinence met with in children may often be cured by means of ergot suppositories.

CHAPTER XXIX

SURGICAL ASPECTS OF SOME OF THE INFECTIOUS DISEASES

Enteric: Perforation of ulcer, peritonitis, cholecystitis, cystitis, bone lesions, typhoid spine, laryngitis, gangrene, parotitis—Scarlet fever: Ulceration, adenitis, cellulitis, post-pharyngeal abscess, otitis media, facial paralysis, mastoiditis, arthritis, bone lesions, peritonitis, gangrene—Diphtheria: Adenitis, laryngeal diphtheria.

ENTERIC FEVER.

THE organism that causes enteric fever is the *Bacillus typhosus*. It has been found in nearly all the tissues of a patient suffering from the disease, so that it is not surprising that complications of a very varied nature may arise. These, however, are relatively infrequent. They may be met with in the course of the fever, or some considerable time afterwards. In the vast majority of cases of enteric fever ulceration of the intestine is the prominent feature, and it is in connection with the well-known enteric ulcer that perforation of the intestine may occur, giving rise to one of the gravest conditions in surgery.

Perforation of Enteric Ulcer occurs in about 3 per cent. of cases, and causes fully one-third of the deaths. It is more frequent in males than females, and is rarely seen in children. While perforation may take place in mild or convalescent cases, it may be said that the more severe the case the greater the chance of perforation; and this is what might be expected, for the worse the case the more extensive and severe is the ulceration, and, consequently, also the sloughing of the ulcers, which is directly concerned with the production of perforation. When the sloughs begin to separate during the third week, the danger of perforation begins. It continues as long as any ulcer remains unhealed. There is usually a single perforation, which is most commonly situated within the last 3 feet of the **ileum.** Other situations affected are the **appendix, colon, rectum,** or **gall-bladder.** The perforation is generally small and circular. The actual cause of the perforation is, no doubt, the separation of the slough, which has involved the peritoneal coat of the intestine. Whether the exciting cause is a sudden movement or strain, such as coughing or straining at stool, or is connected with increased peristalsis or tympanites, is doubtful, but such factors should be carefully guarded against. The wonder is that perforation is not more frequent when one considers the thin base of the ulcer which is left after the separation of the slough.

Symptoms.—In considering the symptoms it is important to distinguish, if possible, between two stages: (1) perforation; (2) the resulting peritonitis. Our aim should be to diagnose the perforation as early as possible, while the peritonitis is at any rate quite localized. It is very necessary to emphasize the importance of early diagnosis.

The patient should be examined immediately on the occurrence of any suspicious symptoms, and under no consideration should any complaint of pain of any description be overlooked. It is well to give special instructions to nurses with regard to pain. They are rather prone to make light of it unless it is severe and lasting.

Is there a preperforation stage? Some observers describe such a stage, characterized by attacks of abdominal pain. Lymph has been frequently seen on the peritoneal aspect of ulcers, and this would account for a preliminary peritonitis; and, again, in some cases of enteric fever laparotomy has been performed after a diagnosis of perforation, and no lesion has been discovered, and within a few hours the patient has perforated. As a rule, however, a preperforation stage is not recognizable.

The onset may be sudden or gradual. When the latter, it is in patients suffering from profound toxæmia. The symptoms are practically those of general peritonitis. The sudden onset is much more frequent; there are local and general signs. The most prominent local signs are pain, tenderness, and rigidity, which may be diffused over the whole abdomen, or more frequently are localized in the right iliac region. The pain comes on suddenly and is very severe; the tenderness is often extremely acute; the rigidity may be confined to a limited portion of one of the recti muscles, usually the right. Pain may in some cases be referred to the end of the penis, or there may be irritability of the bladder. The whole abdomen is immobile, respiration being entirely thoracic. Liver dulness may be obliterated, a sign which is not of much help in diagnosis unless it appears suddenly in a flat abdomen which has been carefully observed from day to day. Together with these local signs there may be a noticeable change in the general condition of the patient. He is somewhat pale and has an anxious expression, the pulse is rapid, and the temperature may show some sudden variation. When the patient is in this condition he must be carefully observed from hour to hour till a definite diagnosis is made. This is the time when operation may be performed with the best chance of success—that is, when the signs are still localized and the general symptoms are slight. With the spread of peritonitis there is soon a great change, the general symptoms becoming more prominent than the local. The local signs may become more marked, or may occasionally disappear. If the latter, one is apt to be lulled into a sense of false security, as the symptoms will return with greater violence later on. The general condition is now much worse. The face is drawn and anxious, cyanotic and bathed in sweat. Vomiting and collapse are present. Rigors may be frequent. The pulse becomes rapid and weak, and the temperature falls, perhaps after a preliminary rise. The significant sign is the **conjunction of a rising pulse-rate with a falling temperature.** Other methods of diagnosis may be mentioned. A count of leucocytes and change in blood-pressure are of little assistance, as results are very variable. Rectal examination is not likely to give help, although tenderness may be felt in some region of the pelvis. If the patient is left without operation, all the features of general peritonitis will soon appear; characteristic facies, rapid running pulse, falling temperature, hiccough and vomiting, abdomen distended and perhaps painful, movable dulness in the flanks, legs drawn up.

Diagnosis.—In a patient suffering from enteric fever, and presenting symptoms such as have been described, the question of perforation

will at once arise. Various conditions may cause difficulty in diagnosis. Abdominal pain is not at all infrequent in enteric fever. It may be due to intestinal colic or to biliary colic. Hæmorrhage from the bowel and cystitis are often accompanied by pain. Pain may also be referred to the abdomen in some general conditions, such as pneumonia. Careful and repeated examinations will generally clear up the diagnosis. Peritonitis (apart from perforation), appendicitis, and various abdominal conditions, such as obstruction or intussusception, may occur in enteric fever; but, as operation is generally called for, the diagnosis of perforation is not of so much importance.

Prognosis.—Peritonitis following perforation is a very fatal complication of enteric fever. The recovery-rate after laparotomy and treatment of the perforation is difficult to estimate, as probably unsuccessful cases are not published. Perhaps 8 per cent. is an average recovery-rate for England. In Canada much better results are recorded—as high as 30 per cent. of recoveries. Possibly in future early diagnosis and greater attention to detail, both in operative and general treatment, may lead to better results. Recovery without operation is not worth practical consideration, although it may occur. A patient at the Eastern Hospital who had a severe attack of enteric fever presented all the symptoms of perforation. He was too ill to be operated on. General peritonitis developed rapidly, and later a localized abscess in the right iliac region. The abscess ruptured into the bladder, and after some symptoms of slight obstruction the patient recovered. Omentum or adhesions may close a perforation, as has frequently been seen in the post-mortem room, but such a possibility should never be used as an argument against operation. With regard to individual cases, except in the case of those suffering from extreme collapse, operation should not be postponed. Patients who are desperately ill sometimes rally in a remarkable manner after operation.

Treatment.—Every patient with enteric fever should be considered as a potential case for a surgeon, and all arrangements should be made with a view to immediate operation should suspicious symptoms arise. It is well for the consent of the patient's friends to be obtained beforehand, so that there may be no delay. Time is of extreme value. Laparotomy should be performed as soon as possible after the diagnosis of perforation is made. If there is a strong suspicion of perforation, it is advisable to do an exploratory operation and to run the risk of a mistaken diagnosis. Such operations have rarely done any harm to patients. Should, however, the symptoms be insufficient to justify operation, it is important that no opium should be given until the diagnosis is cleared up, and it is advisable to prop the patient in a semi-recumbent position at once, with a view to preventing the spread upwards towards the dangerous diaphragmatic zone of any extravasated contents, should it turn out afterwards that there has been a perforation. Local anæsthesia may be sufficient. If general anæsthesia is necessary, ether by the open method is much preferable to chloroform, and the patient should be kept lightly under. Spinal anæsthesia might be usefully tried in this class of case. With regard to the incision, it is best made in the right semilunar line, if, as is usually the case, the signs are pronounced in the right iliac region. If the signs are more general, the middle line is to be preferred. It is easier to make a general examination of the intestines from the central incision, but with a lateral incision the ordinary perforation

is found much more readily. If peritonitis is present, the margin of the skin incision should be protected, as the wound generally suppurates. Usually the situation of the most severe peritonitis will indicate the site of the perforation. If necessary, the whole intestine must be examined carefully; and if no perforation is discovered, the condition of the mesenteric glands, gall-bladder, and spleen, must be investigated. It is well to remember the possibility of an extraperitoneal perforation of the colon. In a case which presented all the typical features of perforation, nothing abnormal was found in the peritoneal cavity, and later an extraperitoneal perforation of the descending colon was discovered. Subcutaneous emphysema was first noticed in the flank, and then a large abscess formed. Rapidity of operation, short exposure of the intestines, and avoidance of unnecessary manipulation, are essential points in the operation.

Drainage should be employed — pelvic always, and in the iliac region or other situations according to the site of the perforation. Irrigation should be avoided, and swabbing only employed if there is gross contamination of the peritoneum with bowel contents.

With regard to the closing of the perforation, if there is only a small hole it should be invaginated and the external coat of the bowel sutured over it. Sometimes, however, there is a large ulcer with a very thin base, the perforation being situated in the centre, or the whole ulcer may be covered by a large separating slough. In such cases enterostomy will be better than invagination. If invagination is practised, the lumen of the bowel may be too much diminished, and the obstruction thus caused to the flow of the intestinal contents may easily be sufficient to turn the scale against a patient who is gravely ill. A case is reported in which a secondary operation had to be performed for the relief of obstruction caused in this manner. In the somewhat rare instances in which there is found a large mass of intestinal wall friable and practically gangrenous, resection is usually out of the question as an immediate operation, so the bowel must be fixed to the abdominal wall. Ulcers which seem likely to perforate should be invaginated.

The after-treatment by the Fowler-Murphy régime is difficult to carry out in enteric fever patients. The patient is so weak and helpless that it is not easy to prevent him from slipping down in the bed, and in many cases it is quite impossible, if it were advisable, to set him bolt upright in bed. However, constant attention by a good nurse will get over most of the difficulty. The patient should not be kept constantly on his back. He should be carefully changed to the lateral position from time to time, and vigilant watch should be kept to avoid the occurrence of bedsores.

Some complications may be met with after the operation. The wound almost always suppurates. Extensive peritoneal bands may develop, and, causing obstruction, may necessitate another operation. A second perforation may also occur.

The following complications and sequelæ of enteric fever are of great interest:

Peritonitis.—This may occur apart from perforation. It may be due to—(1) direct spread, without any evident connection with ulcers; (2) extension from ulcers: in this case fibrinous exudate is found on the peritoneal aspect of the ulcers; (3) suppuration of a mesenteric

gland; (4) rupture of a splenic infarct. Although a very grave condition, it is not necessarily fatal.

Cholecystitis.—When due to the typhoid bacillus, it is an interesting complication, owing to its relation to the production of gall-stones at some later period. Inflammation, ulceration, and abscesses in connection with the gall-bladder have been described. Inflammation may be recurrent, and eventually may lead to the formation of gall-stones, sometimes many years after the original attack of enteric fever. The other lesions may result in perforation.

Cystitis.—A mild type of cystitis is not at all infrequent, especially in females, sometimes following catheterization. In severe cases phlegmonous inflammation of the whole mucous membrane of the bladder may occur, and large casts be passed by the urethra. If a female patient with enteric fever should require to have a catheter passed, the most rigid antiseptic precautions should be employed.

Bone Lesions.—These may appear during the febrile, but are more usual during the convalescent period, or the onset may be delayed till many months afterwards. The long bones of the extremities, especially the tibia, are most frequently involved. There may be merely a localized periostitis, which may subside and recur, but commonly an abscess forms. It is of a chronic indolent type, the pus being thick and greenish, and containing as a rule typhoid bacilli. The abscess does not give rise to acute symptoms, but spreads steadily among the surrounding tissues, so that operation should not be unduly postponed. When the abscess is opened, bare bone will be felt, and some necrosis with superficial exfoliation usually takes place. The abscess and diseased bone must be very thoroughly treated, or a sinus may persist and prove very intractable. It may contain typhoid bacilli for years. Osteomyelitis is much rarer than periostitis.

Typhoid Spine.—This has lately been described as a sequela of enteric fever. The spine is fixed and rigid, and there is considerable local pain and tenderness. It is more frequent in males, and sometimes occurs after quite mild attacks. Periostitis and perispondylitis of some vertebræ are present, and can be recognized by radiography, which should always be used as a method of diagnosis in such cases, more especially as a similar condition is found due to neurosis. The pain may be very severe, and require morphia. A plaster jacket will sometimes have to be worn for some months.

Laryngitis.—This may be met with in severe cases. Ulceration of the mucous membrane occurs alone, or is followed by perichondritis and necrosis of cartilage. A large abscess may form, and cause acute laryngeal obstruction, the symptoms of which develop very rapidly. Œdematous laryngitis is very likely to supervene, and must be carefully watched for. If the symptoms are at all severe, tracheotomy may be required, and it should not be postponed too long. Chloroform should not be given, but local anæsthesia employed. Sometimes patients make a good recovery, even after considerable necrosis of cartilage.

Gangrene.—This is rare, but has occasionally been seen in severe cases. It may occur in connection with (1) venous thrombosis, (2) arterial thrombosis, (3) extensive bed-sores. There may be superficial gangrene of the ears or tongue, or cancrum oris or noma may develop in delicate children. The prolonged application of cold water or ice to a distended abdomen has been known to cause superficial gangrene of the skin.

Parotitis.—When this occurs it generally ends in suppuration; the condition is usually unilateral. In many cases it is no doubt due to the spread of pyogenic organisms from the mouth along Stensen's duct, but sometimes the presence of typhoid bacilli has been demonstrated. The strict attention which is nowadays given to the hygiene of the mouth has rendered this complication somewhat rare. It is very grave when it occurs.

SCARLET FEVER.

Scarlet fever is essentially a septicæmia, and in its course it presents many of the complications seen in any other septic infection. It is almost certainly caused by a micro-organism, probably a streptococcus. There is a local and a systemic infection. The local infection may be assumed to take place in the fauces, seeing that faucial inflammation is constantly present in scarlet fever. It is well to remember, however, the possibility of other paths of infection; for example, the frequent occurrence of this fever in children suffering from burns and scalds suggests that infection may take place through the skin lesion, and in the scarlet fever of puerperal women it is quite possible that infection takes place by way of the uterus. It is important that the faucial lesion should be carefully treated from the start of the disease, as it is impossible to be sure that a mild case may not develop into a severe one, and when the ulcerative process becomes extensive it is often difficult to treat.

Ulceration of the Fauces.—All grades of inflammation may be seen, varying from scanty exudate in mild cases to extensive ulceration and sloughing in severe ones. The tonsils may slough away as well as large portions of the uvula and soft palate. A perforation of the palate is sometimes observed, usually situated on the anterior pillar of the fauces. Such a perforation may remain throughout life as a small pinhole or a large oval hole. More commonly the ulceration extends, and breaks down the margin of the palatine arch, forming a large gap in the anterior pillar. However extensive the ulceration and sloughing of the fauces may be, cicatricial adhesions are not found as a sequela. With regard to treatment, choice lies between swabbing, irrigation, and syringing. If swabbing be gently and carefully performed, it is most satisfactory. Any of the ordinary antiseptics may be used. Perchloride of mercury (1 in 2,000) or izal (1 in 20), are to be recommended. In very severe cases in which there is extensive ulceration of the fauces, more especially if there is any sign of involvement of the larynx, it is advisable to adopt more drastic treatment. Pure carbolic acid may be swabbed over the whole diseased area. A mouth-gag and tongue-depressor should be used, and the ulcerated surface must be carefully gone over with the swab, care being taken that the swab does not contain any excess of the acid, which might escape into the mouth when the swab is pressed against the fauces. The application of pure izal night and morning for a few days is a somewhat milder measure. Treatment on these lines is frequently very successful. In connection with severe faucial ulceration in scarlet fever, the question of the necessity of **tracheotomy** will often arise. There are two classes of cases in which the operation should be seriously considered:

1. In some cases in which there is marked inflammation and swelling of the faucial and nasal passages the patient may have great difficulty

in breathing. He is somewhat cyanosed, and sits up in bed in order to breathe more easily. Further, he is unable to get any proper rest, probably because, when he tries to sleep, his tongue falls back and blocks the already limited airway, the result being that each time the patient falls asleep he has increased difficulty in breathing, and so awakes with a start. Such patients get gradually more and more exhausted, and an early tracheotomy may be of great assistance. In addition to giving the patient relief from dyspnœa and insomnia, the operation has other advantages. A supply of pure air reaches the lungs instead of air which has passed over septic surfaces, and so one can hope to obviate the onset of broncho-pneumonia, which is so often the terminal feature in such cases. The employment of nasal feeding will remove a source of irritation to the inflamed fauces (nasal feeding should be used in all cases of tracheotomy in children, and, indeed, it probably would be advantageous to employ the same method of feeding in any case of severe ulceration of the fauces), and, finally, after tracheotomy the treatment of the fauces can be much more thoroughly carried out.

2. The second class of case in which tracheotomy may be performed with advantage is that in which symptoms of laryngitis appear, pointing to the spread of ulceration to the larynx. The operation may be of great value, for the reasons mentioned before, and, further, it removes the risk of the supervention of œdematous laryngitis, which is usually fatal, and greatly to be dreaded in such cases.

It may not be out of place to say a few words with reference to the general treatment of scarlet fever. Until the organism which causes the disease is identified, vaccine and serum treatment must be purely empirical. Various streptococcal vaccines have been tried, without much success. Polyvalent antistreptococcic sera have also been employed, certainly with more success, but, unfortunately, the results have been very varied (Burroughs and Wellcome's polyvalent serum for puerperal fever has sometimes seemed to give promising results; but large doses must be employed, as much as 50 c.c. on three or four successive days). Another remedy that might be tried more regularly is hydrotherapy. Baths at regulated temperatures, given every four hours night and day, have often seemed to be beneficial. The acknowledged success of the bath treatment in enteric fever might well suggest a more general use of the same treatment in acute infectious diseases.

Cervical Adenitis and Abscess. — The glands in the neck are very frequently enlarged in scarlet fever—in the severe cases almost invariably—and the inflammation often ends in suppuration. The enlargement may be confined to one side of the neck, or it may be bilateral (according to the extent of the faucial lesion). However large the glands may be, they frequently become normal within a few weeks. Poultices, or in mild cases glycerine and belladonna, will help resolution, but in addition the fauces must be carefully treated. If an abscess forms, it heals readily after incision and the usual antiseptic treatment.

Cervical Cellulitis.—Surrounding an abscess in the neck there is sometimes a localized cellulitis, or there may be a general cellulitis of the neck, with or without much glandular enlargement. The whole subcutaneous tissue from the lower jaw to the clavicles may be involved in an acute phlegmonous inflammation. The skin is dark red, swollen, and œdematous, or hard and brawny. Sloughing comes on

rapidly, and if one waits for softening, and then attempts to remove all the necrotic tissue, the whole skin may be peeled off, leaving a clear dissection of the superficial muscles and nerves of the neck. Such cases, if at all extensive, are usually fatal. Early and free incision, followed by antiseptic fomentations, is the best treatment; and if the process continues to spread, the dead tissue should be removed, and the whole of the ulcerated surface swabbed over with pure carbolic acid.

Post-Pharyngeal Abscess.—This is an occasional complication in cases with severe faucial lesions. The abscess may give rise to considerable respiratory obstruction, and is not uncommonly mistaken for laryngeal diphtheria. It is readily recognized if the pharynx is examined with the finger, but may be missed if inspection alone is relied on. The best method of opening the abscess is by puncture with a pair of sinus forceps, the blades being withdrawn in an expanded position. Nasal feeding should be employed for a few days, and the mouth swabbed out frequently. The result is usually quite satisfactory.

Otitis Media.—This occurs in about 12 per cent. of cases of scarlet fever. It may come on at any stage of the disease. As a rule, the more severe the inflammation of the fauces, the greater the likelihood of otitis media. It may, however, be met with in quite mild attacks. The inflammation extends along the Eustachian tube, and this danger must be kept clearly in mind when treatment is being applied to the naso-pharynx. If syringing is ordered, it should be carried out without any force, so as to avoid any chance of septic material being driven into the tube. A better plan is to avoid treatment of the nasal passages, if possible, and to swab the fauces instead of syringing. When the faucial lesions improve, the inflammation of the nasal passages will as a rule rapidly subside.

Otitis media in scarlet fever generally runs an acute course. It usually clears up in a few weeks, and only occasionally develops into a chronic condition. The appearance of a discharge from the ear may be the first sign, or there may be acute symptoms of onset—sudden rise of temperature, persistent crying, sharp pain in the ear, the child holding its hand to the side of its head. In a child, examination of the membrana tympani is often difficult, and it is questionable whether paracentesis tympani is necessary even when rupture of the membrane appears imminent. As a general rule in scarlet fever, after treatment for a short time, the ear discharge clears up, and the membrane heals well without any impairment of hearing. On the first appearance of any symptom suggestive of middle-ear disease, the external auditory canal should be treated with hot antiseptic lotions, and boric fomentations applied over the ear. At the same time attention should be paid to any lesion in the throat or nose. After the discharge has appeared, the usual antiseptic treatment should be employed. If the inflammation becomes chronic, prolonged treatment will be required. Vaccines have been tried in such cases without much success. The organisms found in the discharge are very variable, but the *Staphylococcus pyogenes* is most commonly present. In connection with either acute or chronic otitis media various complications may arise, mostly of a severe nature. They are—

(*a*) *Facial Paralysis.*—This paralysis occurring in the course of an acute inflammatory condition is not nearly so serious as if it occurs in a chronic one. In the acute condition it is caused by extension of inflammation to the Fallopian canal, and it will probably disappear

when the treatment of the ear is effectively carried out. In the chronic condition the paralysis is a much graver sign, and calls for immediate operative interference. It indicates serious disease of the petrous bone, and if untreated may be rapidly followed by intracranial inflammation.

(*b*) *Mastoid Adenitis.*—Inflammation and suppuration of the glands situated over the mastoid process may result from middle-ear disease or from diseases of the external ear. This condition must be distinguished from the mastoid abscess which results from suppuration in the mastoid antrum. Œdema of the eyelids and of the pre-auricular tissues above the zygoma on the affected side is sometimes present, and may be the first sign noticed. The inflammation may involve the periosteum over the mastoid, and cause some superficial necrosis of bone. Such abscesses heal readily after a free incision.

(*c*) *Acute Mastoiditis.*—This is the forerunner of many serious complications. It commonly results in the formation of a mastoid abscess. The antrum may be involved alone or in conjunction with some of the mastoid cells. The earliest symptoms of involvement of the antrum are pain and tenderness behind the ear; the temperature rises suddenly, and there may be a cessation of the ear discharge. At this stage vigorous treatment may cut short the progress of the mastoiditis. Leeches should be applied over the mastoid, followed by hot boracic irrigations of the external auditory canal and frequent hot fomentations. If the ear discharge returns, the acute symptoms will probably pass off. If, however, improvement does not take place within twenty-four hours, operation should be strongly advised. Profuse ear discharge with mastoid tenderness calls for operation, and it is not advisable to wait for marked signs of mastoid disease. A free incision down to the bone under local anæsthesia may be sufficient, but as a rule, if the antrum is involved, mastoidectomy will be required. This operation is very successful in scarlet fever. The middle ear need not be interfered with. The complete radical mastoid operation is rarely necessary except in connection with old chronic ear discharges. Deafness is a very rare result after ear disease in scarlet fever. Following on disease of the middle ear in scarlet fever, numerous complications, intracranial and extracranial, may superevne. Of these, **lateral sinus thrombosis, meningitis, cerebral abscess, cerebellar abscess,** and **pyæmia,** may be specially mentioned.

Orbital Cellulitis is an occasional complication in connection with severe inflammation of the nasal cavity. Its onset is usually accompanied by a marked diminution in the nasal discharge. Copious irrigations of the nasal cavities should be employed, and with the reappearance of the discharge the orbital inflammation may clear up.

Suppurative Arthritis is usually part of a general pyæmia. It has probably no relationship to scarlatinal rheumatism. One or more of the large joints are involved in succession. The affected joint should be incised and drained freely; and if the patient recovers, as is sometimes the case, early passive movement should be employed. As a rule the movement of the joint is seriously impaired.

Bone Lesions.—In connection with the ulcerative stomatitis which is so common in severe cases of scarlet fever, it is not at all unusual to find that some necrosis of the alveolar margin of the upper or lower jaw takes place. The gums are spongy and bleed readily, and the front teeth become loose. The alveolar margin of the jaw is exposed. and a sequestrum may be formed. The body of the jaw is rarely in-

volved. Trauma is an important factor in causing the condition. The patient is generally difficult to feed and to treat, and some force has to be used to get the mouth open. In this way the gums are readily torn and the teeth loosened. Early attention to the hygiene of the mouth, together with extreme gentleness in all manipulations, may help to limit the extent of the disease. The majority of the cases end fatally. Rarely a sequestrum may separate and recovery ensue. Periostitis and osteomyelitis affecting the long bones are also occasionally seen in scarlet fever, not necessarily in severe cases.

Peritonitis.—This is a rare complication which may occur in quite mild cases. It may be associated with acute nephritis, but most frequently no cause can be discovered. The prognosis is very bad.

Gangrene.—This is also a rare complication which may be seen in debilitated patients. The skin is sometimes affected, small patches becoming gangrenous (dermatitis gangrenosa), or large areas of skin may slough. Cancrum oris and noma are occasionally met with. Still rarer is gangrene of the extremities, which is described as occurring in the second or third week of the disease. It is usually attributed to embolism, without any satisfactory proof. The gangrene may be symmetrical, and amputation may be required.

DIPHTHERIA.

Diphtheria is an acute infectious disease caused by a specific micro-organism—the *Bacillus diphtheriæ* (Klebs-Löffler bacillus). It is characterized by a local fibrinous exudate and a general toxæmia. The bacillus is confined to the local lesion, never being disseminated through the body. While growing it produces toxins which are absorbed into the circulation, causing the general symptoms of the disease. The primary lesion is usually situated in the fauces, but any of the other mucous membranes may be affected, especially the nasal and laryngeal. Occasionally infection of the skin and of wounds by the diphtheria bacillus is seen.

Cervical Adenitis.—In faucial diphtheria there is generally some enlargement and tenderness of the cervical glands. In severe cases the whole subcutaneous tissues of the neck are infiltrated with serum, and are swollen and œdematous. There may be a superficial resemblance to abscess or cellulitis, but under the use of antitoxin and poultices the swelling will usually entirely disappear, and incisions are never required. In uncomplicated diphtheria suppuration of the glands of the neck is very rare. If it does occur, it is due to a superadded infection, usually streptococcal. The same may be said in regard to cervical cellulitis. It is very rarely seen, and if present is due to a similar cause.

Laryngeal Diphtheria.—This is usually secondary to faucial diphtheria, the membrane spreading from the fauces ; but it may also be primary, the first symptoms of the disease pointing to involvement of the larynx. Membranous laryngitis may be regarded practically as the same as true laryngeal diphtheria. Diphtheria bacilli are usually present, and the clinical symptoms are indistinguishable. The membrane found on the respiratory mucous membrane varies in character. It is frequently soft and friable, thin, and of a yellow-grey colour ; or it may be thick, stratified, and a pearly-white colour. As it reaches down into the smaller bronchi it becomes more and more friable, and in the

smallest tubes is represented by a thick muco-pus. The membrane is loosely attached, and is easily peeled off, leaving a swollen and injected mucous membrane. When it is well formed, the outlines of the laryngeal and tracheal cartilages are quite distinct. Any part of the larynx, trachea or bronchi, may be involved.

Symptoms.—The affection of the larynx begins with hoarseness, a brassy cough, to which the term " croupy " is commonly applied, and stridulous breathing. These symptoms get gradually more marked, and after a varying time signs of impeded respiration appear—extreme restlessness, retraction of the soft parts of the chest wall and cyanosis. The dyspnœa is at first paroxysmal, probably due to spasm of the muscles of the glottis, but soon becomes continuous, and the child presents a pitiable sight—face anxious, cyanosed and covered with sweat ; eyes protruding ; alæ nasi dilated ; deep recession, all the muscles of respiration in vigorous action ; extreme restlessness, the child throwing itself about the bed and clutching at its throat. The voice is lost, and the pulse is rapid and weak. If not relieved, the exhaustion becomes extreme and the patient dies. In some cases the paroxysmal attacks of dyspnœa are the striking feature, a condition of asphyxia livida being produced. The child may die in one of the attacks, or may become exhausted and sink into a semi-comatose state (asphyxia pallida), death resulting from poisoning of the nerve centres by carbon dioxide. In other cases the symptoms are altogether more gradual in their development. There is an absence of urgent dyspnœa ; there is slight cyanosis and recession ; and prostration is very marked. Membrane is in such cases frequently found to be extensive, involving the trachea and bronchi, and the larynx may not be seriously involved. In an adult symptoms of laryngeal obstruction are never so marked as in a child, and casts of membrane may be coughed up from the trachea without much evident distress. Auscultation of the lungs in laryngeal diphtheria will reveal a loss of the vesicular murmur. In rare cases this may be noticed only over one lung, suggesting that the membrane is limited to one bronchus. A rare complication may be mentioned here. During a violent paroxysmal attack of dyspnœa rupture of the trachea or a bronchus may take place, and give rise to extensive surgical emphysema.

Diagnosis.—If symptoms of laryngeal obstruction occur in a patient with a faucial exudate or a nasal discharge, the diagnosis is almost certainly diphtheria. Even in the absence of a faucial lesion, cultures should be taken from the fauces. It will frequently be found that diphtheria bacilli are present, but more than one culture must be taken—preferably three on successive days—or a culture may be taken from the tracheal mucus if tracheotomy has been performed, or from mucus coughed up through an intubation tube. Various laryngeal conditions may give rise to symptoms similar to those seen in laryngeal diphtheria. There may be acute laryngitis or the early laryngitis of measles, or again, laryngismus stridulus ; but in these diseases the symptoms are not as a rule pronounced. The history is of importance. The presence of fever is rather against diphtheria, and careful examination will generally clear up the diagnosis. Special attention must be directed to the presence of Koplik's spots in the early laryngitis of measles.

If there is marked dyspnœa, recession and cyanosis, it is necessary to exclude large abscesses in the neighbourhood of the pharynx (more especially post-pharyngeal abscess, suppurative tonsillitis, and peri-

tonsillitis), foreign bodies in the larynx, intralaryngeal growths, and growths pressing on the larynx. Here, again, the history of the case, combined with careful examination, will generally clear up the diagnosis. It is only necessary to emphasize the importance of examining the pharynx with the finger in doubtful cases.

Prognosis.—This will largely depend on the extent of the disease and the condition of the fauces. In uncomplicated laryngeal diphtheria, since the introduction of the antitoxin treatment, the prognosis is distinctly good if the disease has not advanced too far. The earlier treatment is begun, the better the prognosis; the early use of antitoxin prevents the spread of the disease. Formerly, in the pre-antitoxin days, laryngeal diphtheria was a most serious disorder. In former days fully 80 per cent. of cases of laryngeal diphtheria required operative interference; now not more than 40 per cent. come to operation. If there is extensive membrane or if broncho-pneumonia develops, the outlook is grave. Diphtheritic paralysis is exceptional after diphtheria of the pure laryngeal type.

Treatment.—The general treatment of diphtheria must be shortly mentioned. **Rest** and **antitoxin** comprise all that is necessary. Local treatment should be avoided. With regard to the dosage of diphtheria antitoxin, one must be guided by the extent of the membrane and the effect produced on it by the antitoxin. In a moderately severe case 12,000 units should be given, and followed by 8,000 units daily till the membrane is seen to be crinkling and separating. In more severe cases larger doses are necessary, but whatever the dose the antitoxin should be given daily till a distinct improvement is produced locally. Subcutaneous injection is the most satisfactory method of administering antitoxin. If the serum is given in sufficient doses before any laryngeal symptoms appear, it is rare to find that any spread of membrane to the larynx takes place. When there is abundant laryngeal or tracheal membrane, large doses of antitoxin are required, and should be given daily as long as there is any re-formation of membrane; and even in milder cases it is advisable to give several successive doses, for if this is done the larynx and trachea clear up more satisfactorily, and there will be less difficulty in getting rid of a tube (intubation or tracheotomy) which may have been used. When the laryngeal symptoms are slight, poultices applied to the neck or steam from a bronchitis kettle are sometimes valuable as a means of relieving the spasm of the larynx, and so gaining some time for the antitoxin to have its local effect. However, if it is practically certain that tracheotomy will be required, steam is of little value, and it is well to operate before giving antitoxin or *immediately* afterwards. The effect of the antitoxin on the membrane is to loosen it, and if there is a complete cast it may be pushed off the tracheal wall in front of the point of the scalpel, and so cause delay in completing the operation.

When to Operate.—The time for interference depends upon the amount of exhaustion present. The state of the pulse and the general condition are important guides. If the dyspnœa is spasmodic, the effect of each attack must be watched. It is usually advisable to operate after three or four severe attacks. If the dyspnœa is urgent and continuous, recession and cyanosis marked or increasing, delay is dangerous. It is well to remember that sometimes the symptoms progress very rapidly, and in some cases a patient in private practice should not be left without operation, whereas in hospital further delay in similar circumstances is justifiable, as immediate assistance is at

hand. Cases which show signs of asphyxia pallida are often very deceptive, if only seen after the patient has been ill for some time. Operation, of course, is urgently required. Patients to all appearance moribund should always be operated on. Tracheotomy followed by artificial respiration is sometimes successful in reviving them.

Two operative methods are advocated: intubation and tracheotomy. Intubation is now established in favour. Its alleged advantages and disadvantages as compared with tracheotomy may be briefly mentioned. The advantages are—(1) anæsthesia is unnecessary ; (2) only a few seconds are required ; (3) there is no open wound, and consequently no scar; (4) after operation the patient breathes through the natural airway, and so there is much less risk of broncho-pneumonia developing than after tracheotomy. The disadvantages are—(1) The danger of membrane being pushed down, and so causing suffocation. This is not a practical objection. If it happens, tracheotomy can always be done at once, or the tube can be withdrawn, and the membrane will probably be coughed up. (2) The membrane cannot escape from the trachea, and so may block the tube. This also is not found to be true in practice. Membrane can escape through the tube, and also around it, with the tube in position ; and, again, if the tube gets blocked, both it and membrane are as a rule promptly coughed up. (3) Ulceration of the larynx, and afterwards stenosis, may follow the operation. This is most unlikely to occur if no force is used, and if no attempt is made to pass the tube if the tissues of the larynx are felt by the finger to be very much swollen. (4) An experienced nurse is required to be in constant attendance, and a doctor must be at hand to perform tracheotomy at any moment. This last objection is very real. It practically limits the scope of the operation to hospital work. Undoubtedly, as a hospital operation intubation is admirable, but two precautions must be carefully observed : the nurse must be competent to express the tube, and tracheotomy instruments must be kept ready. With regard to some other details, the thread should be removed, since it causes ulceration of the mouth, and is a constant source of irritation to the patient. Nasal feeding should be employed, as children cannot swallow with the tube in the larynx. The child must be made to cough every two hours night and day, so as to keep the tube clear; sips of water are given to excite coughing. The tube should be removed at the end of three days, and preferably not reintroduced more than three times. If further relief is necessary, tracheotomy gives better after-results. If there is difficulty in getting rid of the tube, a few doses of opium or chloral may be given before the expression. Before leaving the subject of intubation, it is well to emphasize certain conditions in which the operation should not be practised : (1) extreme exhaustion ; (2) extreme cyanosis : in such cases all unnecessary shock should be avoided, and sometimes intubation may fail to give relief, and so valuable time is lost ; (3) if the laryngeal tissues are markedly swollen and œdematous.

Tracheotomy.—This operation will be required in many cases in which intubation is contra-indicated, and sometimes as a secondary operation after intubation. It is a hazardous operation, especially in young children, in whom the trachea is small and deeply placed. Local anæsthesia may be employed, but it causes swelling and distortion of the tissues, and increases the difficulty of the operation. Chloroform should be avoided, as there is a great tendency to collapse. The only painful part of the operation is the skin incision, so that general anæs-

thesia is hardly necessary. The high is to be preferred to the low operation. There are two methods which may be employed : (1) **dissection,** (2) **stab.** The former should be used whenever possible, the latter being reserved for emergencies. The dissection method aims at exposing the trachea before incising it, and also arresting all bleeding when it occurs. The skin incision should be fairly long—at least 1½ inches. The wound always closes in rapidly, and stitches are not required even in the longest wounds. The thyroid isthmus must be clearly defined, and then the operator will decide whether it is easier to do a high or a low operation. It is well to remember that in children the position of the isthmus varies considerably. It frequently reaches as high as the upper margin of the cricoid cartilage. When the isthmus is exposed, it is a good plan to fasten a pair of Spencer Wells forceps to it. This will serve to anchor the trachea, and so will obviate the use of a hook, which may easily tear it. By pulling on the forceps, a good view of the trachea can be obtained for making the incision, and also for enlarging the incision if necessary. The introduction of the tube is also simplified in this way. In contrast to this, in the stab method of operating palpation takes the place of inspection, bleeding is frequently very troublesome, and it is sometimes difficult to find the incision in the trachea, which may have been made too small in the first instance.

There can be no doubt that, if possible, all bleeding should be arrested before the trachea is incised, but in emergency operations every second of time is valuable, and the trachea must be opened without regard to the bleeding, the head of the patient being dropped over the end of the table so as to prevent blood from getting into the lungs.

With regard to after-treatment a few words may be said. Nasal feeding should be employed from the start. Spraying of the trachea is to be avoided as much as possible. Steam should not be used. The tube should not be disturbed more than is absolutely necessary—certainly not at all for twenty-four hours—and an attempt should be made to remove it altogether at the end of three days. Of course, the nurse in charge must be competent to remove the tracheotomy tube and insert the dilators into the trachea in an emergency. There is sometimes considerable trouble in getting rid of a tracheotomy tube. It may have to be worn for four or five months. Fortunately, however, as a rule the patient is eventually able to dispense with it. The tube should be regularly removed, if only for a few seconds, every day. Intubation is often of assistance. Granulations around the tracheal wound may be excessive, and improvement may follow their removal. Sometimes pure nervousness is a cause of trouble, and the tube can be removed at night or under light chloroform anæsthesia. Belladonna and opium may be given with advantage in certain cases before the attempted removal. The general health of the patient should be attended to, and, if present, enlarged tonsils and adenoids should be removed.

Some after-results of tracheotomy may be referred to : (1) Surgical emphysema around the wound. It is never extensive, and soon clears up. (2) Ulceration and sloughing of the trachea may be seen usually in very severe cases. There may be erosion of a large bloodvessel in the neck, causing fatal hæmorrhage and sudden death. (3) In connection with the tracheal wound abscesses may form in the subcutaneous tissues of the neck.

Lesions of the Skin and Wounds.—Diphtheria bacilli are now recognized as a cause of some skin lesions. Any abrasion or wound may be infected with the bacillus, and may show membrane followed by diphtheritic paralysis. Extensive gangrene of the skin has occurred. Again, auto-infection may take place in a patient suffering from diphtheria, more especially in children with a nasal discharge.

Cases of infection of the **genital organs** have been recorded, and when the lesion is situated on the penis it has been mistaken for chancre. Such cases are, however, much more rare now than in the pre-antiseptic days, and the use of bacteriological examination, followed by antitoxin if necessary, has eliminated most of the dangers of serious results. Similarly, too, it is rare to see nowadays diphtheria of the skin around the mouth and nose, but it is important to remember the advisability of making a bacteriological examination of anomalous skin lesions.

Otitis Media.—This occurs in about 4 per cent. of cases of diphtheria. It is very rarely followed by acute mastoiditis.

CHAPTER XXX

INJURIES TO THE PELVIS

General diagnosis—Fractures—Coccygodynia—Rupture of the urethra—Rupture of the bladder—Injuries to the penis, prostate, and testis—Injury to the rectum—General treatment.

INJURIES to the pelvic bones and to the organs contained within them are not very common. The bones are strong, and considerable violence is necessary to bring about fracture; when this occurs, the accident owes much of its gravity to the involvement of the pelvic viscera.

The organs contained within the pelvic basin are so little exposed to injury that any accident which involves them is almost certain to first produce fracture of the bones. They may, however, be independently injured by stabs made in a downward direction, or by falling on sharp objects when the legs are outspread.

The bladder, when distended, may be ruptured by a force which does not fracture the bony pelvis; the distended bladder, however, may be regarded as an abdominal rather than a pelvic organ.

The forms of violence producing injury to the pelvis are various, but those resulting in fracture of the bones are usually of a crushing nature.

Workmen engaged in occupations necessitating proximity to rolling stock, and the dealing with heavy loads discharged therefrom, are more liable than others to injuries of the pelvis.

DIAGNOSIS OF INJURIES TO PELVIC BONES AND VISCERA.

Fractures of the Pelvis.—It should be remembered that in the adult the pelvis for all practical purposes is one bone, and fracture of a part may be taken as a fracture of the whole. The pelvic bones are so firmly welded together, and are so united by ligaments and overlaid with muscles, that crepitus is extremely difficult to elucidate. Indeed, in examining a patient who has met with a crushing accident, it is useless to try and determine fracture by the classical signs, and the lesion is often extremely difficult to locate except in fracture of the crest or the upper expanded portion of the ilium. It is unwise to try to elicit crepitus by vigorous movement, since it is a comparatively rare thing to meet with fracture of the pelvic bones without injury to the contained viscera, and such movements will very possibly increase the harm done.

Two diagnostic points are of great value—*i.e.*, **abnormal mobility,** though this is not always present; and **local pain,** which is frequently felt at or near the point of fracture.

In examining for these signs, a hand should be placed firmly on either side of the pelvis and gentle pressure exerted.

X rays are particularly valuable in diagnosing fracture of the pelvic bones.

The **Acetabulum** may be fractured by a force which is transmitted through the femur, resulting from a fall upon the feet or on the great trochanter. The cavity may be fissured, or the head of the femur driven through into the pelvic cavity, and the injury may then be mistaken for a fracture of the femoral neck, from which it is distinguished by the flattening of the great trochanter and the presence of the head in the pelvis, where it may be felt through the rectum or vagina. The head should be disengaged by traction, and subsequently the limb placed in a long splint and extension applied.

Fractures of the Constituent Bones of the Pelvis—The Ilium.—The expanded portion may be broken by direct violence, or the crest may be separated by similar forms of injury. If the ala is involved, the fracture usually extends backwards or forwards from the prominence near the centre of the crest. The spines may be torn off by strong muscular contractions.

The **Ischium** is rarely broken apart from a general fracture. When occurring, it is usually due to a fall or blow upon the buttocks.

The **Sacrum** may be broken transversely by a fall or blow, the lower fragment being bent forwards into the pelvis, where it may injure the rectum. As part of a general fracture of the pelvis, it is usually the upper part of the bone which is broken in a longitudinal direction.

Coccygodynia is a painful condition which is sometimes set up by a fall or blow at the lower end of the back, and if occurring in a patient of a neurotic type may lead to grave trouble. Often nothing short of operation is of any use to cure the condition.

The **organs** usually involved in fracture of the pelvis are the urethra and bladder; less frequently the rectum; occasionally the external iliac artery or vein may be injured; the bones may be driven upwards and produce rupture of some of the abdominal organs: this is a rare though quite possible accident.

Should the **Urethra** have been ruptured, there will be as a rule inability to micturate, together with pain in the perineum and referred pain at the end of the penis; swelling of the perineum, and of the penis and scrotum; while, if the catheter can be passed, a small amount of blood-stained urine will be drawn off. Occasionally the patient can with great effort micturate, but he should not be allowed to attempt the act.

In **Rupture of the Bladder,** the symptoms will differ according to whether the rupture is **extra-** or **intra-peritoneal**. If it be the former, a dull swelling appears above the pubis, and on passing a catheter only a small amount of urine can be drawn off. Unless the rupture be a small valvular one, the injection test should not be depended on. The catheter may be passed through the rent in the bladder, and felt above the pubis. Retention, or it may be incontinence, is present.

If the bladder be ruptured **intraperitoneally**, there will be no swelling above the pubis. The other symptoms just referred to will, however, be present, and in addition there will be more shock and a slowly-developing septic peritonitis.

The diagnosis of injuries to the urethra and bladder produced in other ways than by fracture of the pelvic bones will not differ materially from that already given. It cannot usually be stated with any degree of certainty whether the injury was received at the same time as the fracture, or whether it was due to puncture or laceration produced later by the fractured bones.

The **Penis** may be injured, but requires no special diagnosis, the condition being obvious.

The **Prostate** may be injured either with or without involvement of the urethra. In the former case pain and swelling will occur in the perineum, and if infection occur from the rectum a peri-prostatic abscess will result. If the urethra be involved, the hæmorrhage is severe, and even fatal should the prostatic plexus be injured.

The Testis.—If the violence be direct, as in a kick or blow on the scrotum, the body of the organ will be affected, and can readily be diagnosed by the history and examination. When the violence is indirect, as in severe straining in lifting a heavy object, the epididymis and vas deferens will suffer and become inflamed and painful. This must be carefully diagnosed from diseased conditions. It is unusual for this organ to be directly injured in fracture of the pelvic bones.

For further details of injury to genito-urinary organs, see Chapter XXXI.

The Rectum.—The rectum may be injured at the same time as the pelvic bones are fractured, but not so commonly as the bladder or the urethra. A stab in the perineum or a fall upon that region is the more usual source of injury.

A violent strain may cause rupture of the gut, as in lifting heavy weights, but is more usual during defæcation; if it occur at that act, and any injury be met with about the same time, the issues may be confused.

The principal points to investigate for purposes of diagnosis are—the history of the accident; the local signs of injury, external and internal; the escape of blood, and possibly of some portion of intestine, through the anus or the vagina in the female.

Infection is almost certain to take place later, when an ischio-rectal abscess will form. Occasionally peritonitis occurs, and is due to the peritoneal attachment being torn through. Should the patient show signs of profound shock, or the initial shock deepen instead of passing off, internal hæmorrhage should be looked for, as the bleeding is sometimes not apparent, and a large amount of blood accumulates in the rectum and the neighbouring portion of the large gut.

Treatment.—In treating a general fracture of the pelvis, the patient should be moved or handled as little as possible, lest injury be done, or existing injury increased, to the contained viscera. The patient should be placed upon a firm mattress, and examination made to ascertain if any viscus has been injured; especial attention should be paid to the bladder and urethra, and it is well as a routine treatment to pass a catheter after pelvic injuries. For treatment of the fracture, a firm binder or a many-tailed bandage is applied round the pelvis, after the fragments have been reduced as much as is possible or wise. The knees should have a thick pad of cotton-wool placed between them, and be fastened together with a bandage. The patient should be confined to bed or a couch for several weeks.

When portions of the ilium are separately fractured, strips of ad-

hesive plaster are usually sufficient to retain them in place when the muscles attached to the fragments are relaxed. When the spines are separated, they may have to be pegged in position.

Transverse fractures of the sacrum may require wiring if strapping does not keep the fragments in apposition.

In rupture of the bladder the indications are to get rid of the extravasated urine and to close the rent in the bladder as soon as possible.

CHAPTER XXXI

GENITO-URINARY DISEASES IN THE MALE

General examination of the kidneys—Abnormal conditions: Congenital, acquired—Inflammatory conditions—Tuberculous disease—Renal calculi—Renal colic—Tumours of the kidneys—Renal parasites—Syphilis—Injuries—The bladder: Congenital conditions, tuberculosis, ulcers, tumours, calculi, parasites, functional derangements, examination of the urine, injuries—The prostate gland: Prostatitis, tuberculous disease, new growths, prostatectomy—Urethra and penis: Malformations, structure, foreign bodies, growths, injuries—The testis: Congenital conditions, inflammatory infections, syphilis, hernia testis.

DISEASES OF THE KIDNEY.

GENERAL EXAMINATION OF THE KIDNEYS.

Modern methods of examination of the kidneys and other organs of the genito-urinary system have done much to elucidate morbid conditions formerly little understood, and to make diagnosis very much more certain than was possible previous to their employment.

It is a matter of the utmost importance, in suspected disease of the kidney, not only as far as possible to make certain of the nature of the disorder, but also to ascertain if the second kidney is present. and, if so, that it is in proper working order, as on this will depend the advisability or possibility of operative procedure being undertaken on the diseased organ.

Unless in thin subjects, the kidney is not an easy organ to be examined through the abdominal walls, and frequently nothing abnormal can be detected although the kidney is diseased. The younger and more inexperienced the student, the more certain he is that he can detect an enlarged or floating organ, and those who can feel nothing but muscle and fat do not care to own to their supposed lack of manipulative skill. It is well never to acknowledge that the normal organ is felt, still less to say that the kidney is enlarged, unless no reasonable doubt is entertained on the subject, since a student thus acquires a slipshod habit of diagnosis.

Inspection and **percussion** will reveal little in examining the kidney. There remain—

Palpation.—In experienced hands this is valuable. The best position is the dorsal, with the legs slightly flexed, the examination to be carried out just at the end of inspiration. Morris prefers the patient to lie on the sound side, with legs drawn up and the body inclined to the front. In this position there is the advantage that the intestines are out of the way and the lumbar region is sunk in.

Rénal Ballottement.—By this method of examination the kidney is carried forwards by sharp blows upon the lumbar region by one hand, while the other is laid flat upon the abdomen and feels the organ as it comes forward.

Procédé de Pouce.—The fingers of one hand are placed behind the organ, and the thumb in front; the fingers are then pressed firmly forwards, and the kidney palpated with the other hand.

The latter two methods are really modified palpation.

The **spleen** on the left side, and a **distended gall-bladder** on the right, have to be distinguished from the kidney, not always an easy task.

Examination by the **X rays** is quite unreliable for diagnostic purposes unless in the case of certain calculi—oxalates and phosphates—and even these are sometimes not demonstrated.

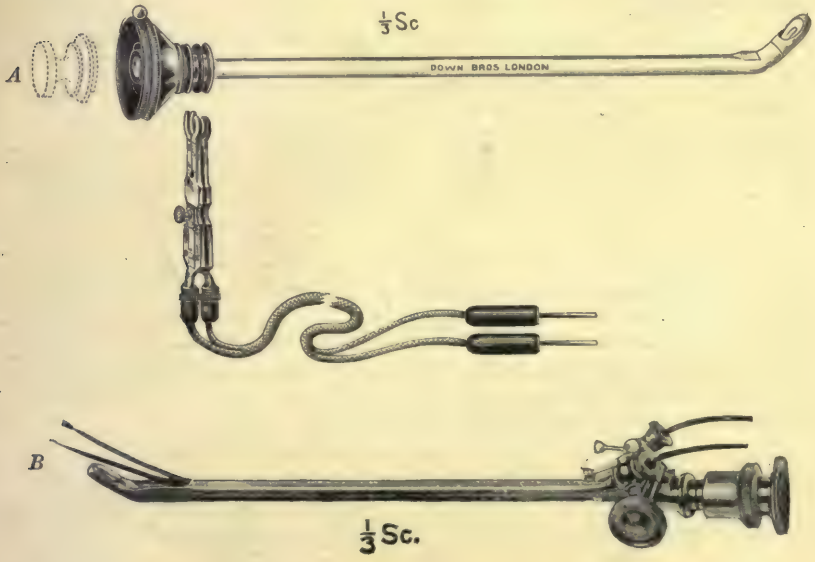


Fig. 107.—*A*, Max Nitze's Cystoscope for Examining the Bladder; *B*, Max Nitze's Cystoscope for Simultaneous Catheterization of Both Ureters.

Cystoscopy.—The cystoscope has proved one of the most useful adjuncts to diagnosis in modern times. By its use the orifices of the ureters can be examined, and much learned by their appearance and shape, by the rate of secretion, as well as by observing pus or blood passing from them. By its aid the ureters can be catheterized and examination made of the fluid or matter passed through them. In this way the condition of either kidney can be separately determined.

The **functional activity** of the kidney may be roughly tried by injecting **sulphindigotate of sodium** and observing the time taken for it to appear at the ureteral orifices (chromocystoscopy).

Two grains of the salt are mixed with 2 drachms of sterilized water. The mixture should not be boiled, as a thick emulsion is produced

which will not readily pass through the ureters. Fifteen minims of the solution are injected into the buttock with a serum syringe, and the time noted, which varies from eight to thirty minutes, before it appears in the bladder.

The method is not a reliable one, but is useful in that it shows plainly the orifices of the ureters. A 4 per cent. solution of methylene blue, of which 4 c.c. are injected into the buttock, may be used instead of sulphindigotate of soda.

Fullerton depends for guidance as to the functional activity very largely on the relative **specific gravity** of the excretion of the two organs. On the diseased side he has found that the specific gravity is lowered, probably owing to an increased circulation in the affected kidney from the presence of an irritant. The following table prepared by Fullerton may be taken as a rough guide as to when to operate, provided repeated examinations give the same relative specific gravity.

	Diseased Kidney.	Normal Kidney	Operative Interference.
Specific Gravity ..	1005	1015 (or above).	Justified.
,, ,, ..	1005	1010	Doubtful.
,, ,, ..	1005	1005	Not justified.

The amount of urine secreted by the two kidneys may vary though both are healthy. It has, however, been shown by Casper and Richter that, though the fluid bulk may differ, the **nitrogen** and **salt contents,** the **molecular concentration** (cryoscopy of the urine), and the **sugar excreted,** after injection of *phloridzin,* will be approximately the same if both organs are normal, and they hold that this is the most accurate method of testing functional capacity.

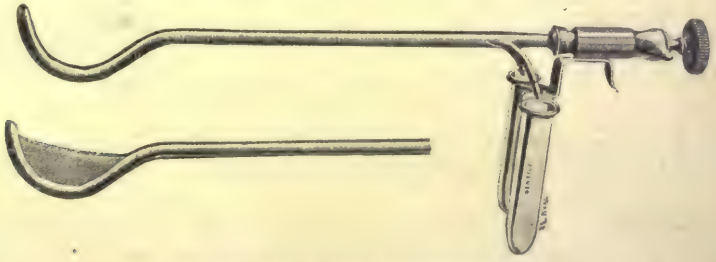


FIG. 108.—LUYS' SEGREGATOR.
(Casper.)

Cryoscopy, or the testing of the freezing-point of the blood, taken alone is not very reliable as an indication of functional activity, since other conditions than renal ones may influence the result. Kümmel is of opinion that a fall of the freezing-point of the blood to – 0·58 or – 0·60 C. is proof that both kidneys are acting insufficiently, for a single kidney doing its normal work will keep its freezing-point from falling below – 0·56 C. If, then, the freezing-point of a given specimen of blood is below – 0·56 C., it is a contra-indication to removal of the

kidney, since the supposed sound organ is not functionally active, and there is too much urea circulating in the blood.

Instead of catheterization of the ureters, the urine secreted by each kidney may be roughly collected by means of a **segregator,** which, as in the case of the instruments of Luys and Cathelin, makes a more or less water-tight division between the ureteral orifices, and in the case of that of Harris makes a division by elevating the posterior bladder wall. This method is not so accurate or satisfactory as catheterization of the ureters.

ABNORMAL CONGENITAL CONDITIONS.

Certain conditions of the kidney are found as congenital defects, which may persist in adult life. They are—

Complete absence of one kidney—a rare condition, but one the possibility of which must be borne in mind.

Complete atrophy of one organ.

Deep lobulation, perhaps dividing the organ into two or more.

Kuster does not recognize the existence of **multiple kidneys,** but regards the condition to be rather a normal number with multiple pelves and ureters. If lobulation persist in the adult, the term **fœtal kidney** is applied to the condition. A special predisposition to tuberculosis seems to attach to this malformation.

Double pelves and ureters, which may fuse below the pelvis or be continued to the bladder.

Both kidneys may be fused in the middle line, constituting what is known as **horseshoe kidney.** The concavity is **usually above.** The isthmus may be formed of true kidney substance or merely of fibrous tissue.

Dystopia is the term applied to congenital displacement of the kidney. This displacement is most usual on the **left side,** and the organ may be normal or abnormal. The kidney may be found over the **sacro-iliac synchondrosis,** or at a higher level than usual. A normally-placed kidney may have its pelvis in an abnormal position, usually on the anterior surface.

Cystic disease, sarcoma, and hydronephrosis, may occur as congenital conditions.

ABNORMAL CONDITIONS WHICH MAY BE CONGENITAL, BUT ARE MORE USUALLY ACQUIRED.

Floating Kidney.—This is a rare congenital condition in which the organ is entirely surrounded by peritoneum, and has free movement owing to its possessing a *mesonephron.*

Movable Kidney.—In this condition there is a certain amount of mobility on account of the absorption of the pad of fat on which the kidney lies. Casper states that the organ is also **abnormally situated** ; it is not necessarily so. The condition is fairly frequent in women who have borne many children and have pendulous abdomens. On the other hand, it may be met in the opposite type. Anything which tends to cause pressure on the kidney, especially in a downward direction, and so loosen its attachments, may also cause the condition. It is possible that it is secondary to an hereditary predisposition owing to unusual anatomical arrangements. It is

sometimes caused by traumatism, in which case it is usually found in the **male.** The condition is contributed to by chronic constipation.

Symptoms.—These are in most cases of an indefinite neurasthenic nature, but in some they are more definite, as—pain which may shoot down the leg, and is increased by long standing or exertion, and a dragging sensation on one side. In certain cases the kidney in its descent has dragged the ureter and more or less kinked it. If this has happened, there will be periods when, owing to distension of the pelvis of the kidney, the symptoms simulate renal colic. This is accompanied by decreased flow from the affected side.

Treatment.—There is only one satisfactory treatment for well-marked mobility of the kidney from whatever cause, especially when accompanied by repeated attacks of colic—namely, placing it in its normal position and suturing it there. Whether the sutures pass through the capsule, split or unsplit, or through the kidney substance, and whether the organ is slung by sutures passed through the periosteum of a rib or muscular tissue, or both, is of little import so long as it is firmly attached and will not slip. Nearly every operator has his own method. Casper merely strips off the capsule, and trusts to adhesions forming between the fatty capsule, the muscle, and the kidney.

The wearing of abdominal belts and supports is not very satisfactory, and is only to be advised if the patient objects to operation, when it is contra-indicated by the general condition, or where there is marked neurasthenia. The belt should always be put on before the patient leaves bed.

ABNORMAL ACQUIRED CONDITIONS.

Hydronephrosis.—A condition characterized by distension of the pelvis and calyces with urine as the result of obstruction to its outlet.

Causation.—Sometimes the condition is congenital, when it is due to developmental errors. The ureter joins with the kidney after the latter has developed from the *metanephros.* This junction is not always complete and normally formed, and well-marked obstruction occurs. The tumour so formed has been known to be large enough to interfere with the birth of the child.

The acquired form is due to—

1. Blocking of the urinary passage by calculi, parasites, foreign bodies, or blood-clot.
2. Inflammatory swelling of the mucosa, cicatrices, stenosis, and tumours.
3. Kinking of the ureter of a floating kidney.
4. Pressure of external tumours or cicatrices as after pelvic cellulitis.

Morris classifies the causes of hydronephrosis as—

1. Those **behind the bladder** : Stones in the ureter, parasites, foreign body, stenosis, kinking, and congenital causes.
2. Those **in the bladder** : Cystitis, by swelling of mucous membrane about the ureteral orifices, stone, tumour, etc.
3. Those **in front of the bladder** : Stricture, narrow meatus, phimosis.

The last is considered by some to be the most common cause in

young children, but, considering the great frequency of this condition as compared with the number of cases of hydronephrosis, this view cannot well be accepted where phimosis is a single factor.

A sudden and complete block never causes hydronephrosis. In such a case secretion is suppressed. It is only when the block is not quite complete, or if complete is intermittent, that hydronephrosis occurs.

Pathology.—Dilatation of the ureter and pelvis is soon followed by expansion of the calyces, the pyramids become flattened, and the cortex expanded and thinned. Interstitial infiltration of the cortex follows. The urine is abundant and of low specific gravity.

Later on the renal tissue becomes more and more atrophied, until finally it disappears entirely, the kidney being represented by a thin-walled multilocular cyst.

At any stage **septic phenomena** may show themselves, giving rise to *pyonephrosis*.

Clinical History.—This varies according to the cause producing the condition. If we take the average case, **there is a tumour in the loin, which varies in size from time to time.** There is painless enlargement of the kidney and free secretion of pale urine of low specific gravity, and finally **anorexia** and **uræmia.**

No urea is present in hydronephric fluid.

Treatment.—Remove the cause. Perform nephrotomy and treat the condition locally. If the case is of long duration or other treatment is of no avail, the kidney should be removed.

INFLAMMATORY CONDITIONS OF THE KIDNEY AND SURROUNDING TISSUE.

It should be borne in mind that, while different names are given to inflammatory conditions of the kidney according to the anatomical part affected and the clinical evidence, yet one may be merely a stage of another, and all have much in common.

Infection of the kidney may come through the blood-stream or from the urinary tract. The former is termed **hæmatogenous,** the latter **urogenous.** Infection also occasionally reaches the kidneys from neighbouring organs, as the liver and intestines.

Pyelitis.—Inflammation involving the pelvis and calyces, and at times the ureter.

Causation.—1. Presence of calculus or the passing of uric acid crystals in gouty subjects.

2. Extension of septic conditions of the bladder.

3. Extension of gonococcus infection.

4. Extension of tuberculous infection from the bladder or primary infection of the kidney.

5. Malignant disease of the kidney.

6. Occasionally present as a result of floating or movable kidney.

7. After ingestion of irritating drugs — cantharides, turpentine, cubebs, or copaiba.

8. As a result of the presence of foreign bodies or parasites.

9. Pyæmic embolus or infective fevers (hæmatogenous).

10. Possibly as a result of a severe chill, or of injury.

Pathology.—The lining membrane of pelvis and calyces becomes congested and thickened, and secretes a muco-purulent or purulent

discharge. Owing to the swelling of the mucous membrane, the ureter is encroached upon, and a certain degree of *hydronephrosis* is set up. In those cases in which a micro-organism is present, as in extension from the bladder, the whole kidney will probably become involved, and *pyelonephritis* be set up; or the condition may be followed by a *urinary abscess* pointing in the loin or by *suppurative perinephritis*.

Symptoms.—Pain and local tenderness; increased frequency of micturition; intermittent discharge of **pus in acid urine.**

Treatment.—Remove the cause, if possible.

Be careful to prevent further infection from the lower urinary passages; therefore draw off septic urine and wash out the bladder.

The patient should be kept in bed, and the loins cupped or fomented. Alcohol and opium are to be avoided. Plentiful bland drinks should be ordered. If the temperature remains high, give sulphate of quinine with a free hand.

In ascending pyelitis, where grave symptoms persist, operative procedure should be undertaken with a view to splitting the kidney and applying treatment locally.

Pyelonephritis (Surgical Kidney).—This condition is an inflammation of the pelvis, together with the renal parenchyma. The **pyramids as they dip into the calyces** are first affected. The condition is almost invariably suppurative in type, and is usually due to extension upwards from the lower urinary organs, and constitutes the chief element in the more serious cases of what used to be called "surgical kidney." Infection may also occur through the blood-stream.

Pathology.—Septic organisms travel upwards, and start foci of inflammation in the ureter and the renal pelvis. This spreads to the kidney substance, or sometimes several of these small foci run together to form a considerable accumulation of pus, which may be recognized externally. More usually the patient dies from uræmia or toxæmia before this stage is reached. In chronic cases the condition of *pyonephrosis* is more marked.

Symptoms.—It is often found that the first symptoms appear after catheterization, or some such procedure, carried out in the case of a patient suffering from severe cystitis. There is headache, rigor, pain in the back, vomiting, drowsiness passing into coma. The rigor may be repeated, or the temperature may remain high without exacerbations. The urine is diminished in amount, or may be entirely suppressed.

True uræmia is only present when the secretion of urine is suppressed, not when secreted urine is absorbed.

The symptoms are probably due to the circulation of **carbonate of ammonia** in the blood, or it has been suggested they may be due to the disorganized kidney being unable to secrete some substance necessary to the body's well-being. The exact nature of the poison causing the symptom is unknown.

Treatment.—As for pyelitis.

Pyonephrosis.—Distension of the pelvis of the kidney when associated with suppurative pyelitis. The condition is always secondary to pyelitis or hydronephrosis.

Pathology.—The lining of the pelvis is inflamed, thickened, and perhaps ulcerated. A considerable amount of decomposing urine mixed with pus is found in the dilated pelvis and calyces, while calculi and tuberculous masses may also be present. A certain amount of perinephritis accompanies the condition.

Symptoms.—The kidney is enlarged and tender, there is constant pain, the temperature is raised, and the patient usually loses flesh to a great extent. The tongue is dry and coated, appetite absent, while the urine gradually diminishes in amount. The fatal end is usually brought about by uræmia, toxæmia, or pyæmia.

Treatment.—If the condition be unilateral, nephrotomy should be performed, and the kidney dealt with locally. If it is bilateral, little or nothing can be done.

Abscess of the Kidney.—This may result from any of the preceding inflammatory conditions in which micro-organisms have gained access from below. It may also occur in *pyæmia* and the general infective fevers.

Pathology.—The pus gradually distends the tubes, which have a white thready appearance ; and if the process goes on for long, they break into one another, forming a large abscess cavity.

Symptoms.—Pyuria, together with general constitutional symptoms, and local swelling if the accumulation of pus is of any extent.

The chronic abscess is almost invariably tuberculous in nature, and with it there may be no pyuria or pain, but simply a swelling in the region of the kidney.

Swelling need not always be present ; indeed, owing to destruction of kidney substance, there may possibly be a diminution in the normal size.

Pain and tenderness, when present, are useful indications, but they may be absent.

Treatment.—Give exit to the pus by an incision at the outer border of the *erector spinæ* muscle. Examine the kidney locally, and remove the cause if possible.

Perinephritis.—This condition cannot usually be recognized unless suppuration occur.

An effort has been made to differentiate between *perinephritis* (inflammation of the capsule of the kidney), *epinephritis* (inflammation of the fatty capsule), and *paranephritis* (inflammation of the retroperitoneal fat).

Such a distinction is largely artificial, for, whatever may be the site at the beginning of the affection, clinically it is usual to find all three structures involved in the process.

Pathology.—The capsule is thickened and becomes adherent to the kidney, and small foci of suppuration develop. The pain produced is often severe, owing to the adhesions causing traction on the organ and its nerves. The pain simulates renal colic from other causes.

The structures behind and around the kidney may become affected from an extension outwards or from contusions and wounds in the region of the kidney, often leading to extensive suppuration.

Symptoms.—These may be acute or chronic. In the former case there is an indurated painful swelling, accompanied by fever, and

perhaps rigors. Fluctuation may be detected, and the pus may burst into the peritoneal cavity. In the latter case there are no characteristic symptoms till the abscess forms.

Treatment.—When pus has been detected, an opening should be made, and the further treatment carried out symptomatically.

TUBERCULOUS DISEASE OF THE KIDNEY.

This condition, sometimes known as **Nephro-phthisis,** may occur in one of three forms :

1. As part of acute general tuberculosis.
2. As an upward extension from a similar affection of the bladder, in which case both kidneys are as a rule affected. This form of infection is not common.
3. As a primary infection from the blood-stream, which usually starts as a deposit of tubercle **in the cortex** or at the **base of one of the pyramids.** As a rule one kidney only is affected.

Diagnosis from Renal Calculus.—This is a matter of some difficulty if the tubercle bacillus is not found in the urine. The chief points of distinction are—

1. The condition is less influenced by rest or exercise.
2. There is less hæmaturia and renal colic.
3. The kidney is not so tender on manipulation.
4. The condition is much less common.
5. Inspection shows the kidney to be mottled and pallid-looking, while small nodules containing caseous matter or pus are scattered over the surface, and there is a matting together of the capsule with the surrounding tissues.
6. The urine withdrawn by the ureteral catheter from the affected organ is pale and turbid, shows diminution of solids, and often contains the bacillus. Evidence from this source should only be sought in the early stages of the disease. Later it is difficult to use bladder and ureteral instruments, and they may do harm.

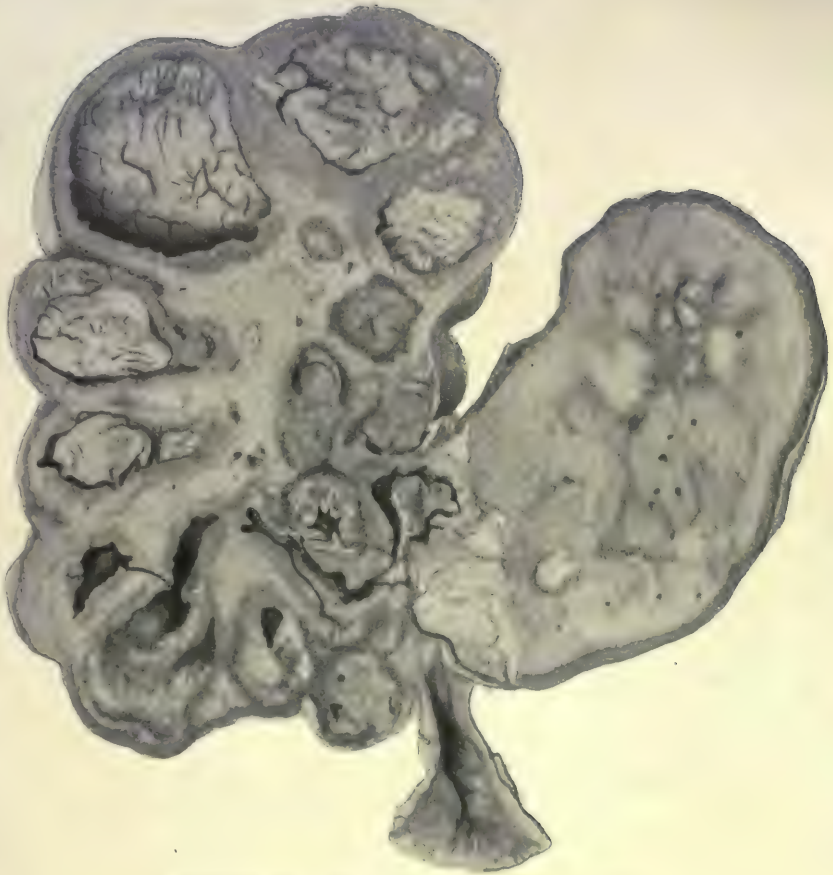
Pathology.—When the disease is primary, the usual type, cavities are formed by liquefying caseous masses, or the kidney may be studded over with small nodules. The whole organ may be involved, or the disease may be confined to one pole, probably owing to its separate blood-supply. The disease progresses until the kidney becomes a tuberculous abscess, with a thickened capsule for its wall. The ureters are involved in old-standing cases, the lumen frequently becoming obliterated, and the infection may spread downwards to the bladder. When the infection does not spread from below, the lesion is usually unilateral, but one kidney often affects the other.

General tuberculosis may result from extension of the disease to the whole genito-urinary system, the joints, and the lungs.

Symptoms.—Early symptoms may be marked, or there may be none. Subsequently constitutional symptoms show themselves, and a palpable renal tumour and urinary changes are evident. The urine contains pus, and sometimes small masses of caseating material, in which the tubercle bacillus may be found. Albumin and blood may also be present.

Under two circumstances the urine voided by the urethra may be **quite normal**—*i.e.*, when the foci of the disease are isolated, and when

PLATE LXVII.



TUBERCULOUS DISEASE OF HORSESHOE KIDNEY.

(Museum, Queen's University of Belfast.)

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the ureter is blocked. Should the bladder become involved, the symptoms of strangury and tenesmus, which may be present owing to the renal condition, become marked. There may be symptoms or signs of localized tuberculosis in other regions, or of general tuberculosis.

When the bladder is examined by the cystoscope, it will be found that, owing to the presence of pus, the walls are not seen very clearly if the urine has not been voided for some time. When the urine has been drawn off and the bladder partially filled with boric lotion, the walls are seen to be healthy; but the orifices of one or both ureters are found vascular and distorted in shape, sometimes resembling a horseshoe, while small ulcerations are present around the edges. Pus may be observed coming from the ureter, and if the latter be catheterized the tubercle bacillus may often be found in the excretion.

Prognosis.—This will depend upon whether the disease is bilateral or unilateral, and whether it is accompanied by general tuberculosis or not. In the latter case, and when both kidneys are affected, the prognosis is bad, though life may be prolonged for years. Should the disease be limited to one kidney, and the case be seen early, the prognosis is good.

Treatment.—When both kidneys are affected, or when there is general tuberculosis, the treatment must be symptomatic. Care should be taken to keep the bladder as healthy as possible.

If the second kidney is in good working order, the affected one should be removed. This is done, though there may be some involvement of the bladder, and even tuberculosis of the lungs, as the bladder will probably recover its healthy condition after removal of the infecting kidney, and early pulmonary tuberculosis is an eminently curable disease.

In removing a tuberculous kidney, it is often necessary to leave the capsule behind, owing to its close adhesion to the surrounding tissues.

When the ureter is extensively involved, it should be removed in its entire length at the same time as the kidney.

RENAL CALCULI.

This condition occurs in those who suffer from lithiasis, as indicated by the passage of sand or gravel in the urine. As a rule they are excreted from the tubules in a crystalline form sufficiently small to pass to the pelvis, and thence along the ureter to the bladder, where they form the nucleus of a vesical calculus or are expelled with the urine. If, however, the concretions be too large to pass along the ureter, they congregate and grow in the pelvis of the kidney, perhaps filling it entirely and protruding into the calyces and ureter, and taking the shape of the parts filled; or the concretion may become lodged in the kidney substance or in one of the calyces without passing into the pelvis.

The calculi may be **primary,** uric acid, urates, oxalate of lime, and occasionally cystin or xanthin; these are usually formed in acid urine. They may be **secondary,** phosphate or carbonate of lime and phosphate of magnesia; these are usually formed in alkaline urine and deposited on a foreign body as mucus, pus, or blood.

The primary calculi usually consist of uric acid or urates of soda or

ammonia, but oxalate of lime calculus produces more severe symptoms, and is therefore most frequently removed.

According to Fullerton and Thelwall Thomas, renal calculi are almost invariably composed of calcium oxalate.

Mixed calculi are those composed of several of the above substances.

Pathology.—If the calculus be lodged in the parenchyma, little effect is as a rule produced.

If lodged in a calyx, ulceration of the wall will follow, leading to *perinephritis*, with perhaps the formation of an abscess cavity in which the calculus lies.

If lodged in the pelvis, in a few cases it does not produce pathological changes, but as a rule *pyelitis* is set up, and from the obstruction to the flow of urine *hydronephrosis* or *pyonephrosis* results.

If lodged in the ureter, and completely occluding it, **calculous anuria** results, due to sudden complete obstruction, usually in men whose second kidney is abnormal or diseased; usually, if partial obstruction only exists, *hydro-* or *pyo-nephrosis* will result, or the calculus may ulcerate through the wall, and may lead to retro-peritoneal abscess or suppurative peritonitis.

Symptoms.—Acute pain in the loin radiating along the genito-crural nerve to the front of the thigh, with retraction of the testicle. The pain may be referred to the back of the thigh and leg, and is increased by any jolting motion.

If the stone be in the parenchyma, pain is present, but urination is not interfered with, and the patient will lie at night on the affected side; if, however, the stone be in the pelvis, the patient will lie on the sound side, because the kidney is as a rule enlarged and tender. There is usually frequent micturition.

It must be clearly understood, however, that a stone may exist in the kidney for years without giving rise to symptoms.

When the stone passes into the ureter, it gives rise to **renal colic,** and is evidenced by severe pain of a paroxysmal character referred along the genito-crural nerve, vomiting, strangury, frequent efforts to pass water, and the actual passage of a small amount of blood-stained urine. After these symptoms have lasted for a variable time, the pain suddenly ceases, owing to—

1. The stone passing into the bladder.
2. The stone slipping back into the pelvis.

When the stone is lodged in the ureter, **calculus anuria** results. It is seldom complete at first, and is ushered in by severe pain in the loin. After about a week, symptoms of **uræmia** manifest themselves. They are—Vomiting; slow, full pulse becoming irregular; contraction of the pupils; muscular tremors. Coma and convulsions are seldom seen, and there is no dyspnœa; the temperature is subnormal.

Diagnosis from tuberculous disease of the kidney has to be made, and has already been referred to.

Treatment.—Diet and general habits should be regulated. Alkaline purgatives and bland drinks administered. For the attacks of renal colic, morphia should be given hypodermically.

If the pain persist, or the local symptoms of tenderness and pain indicate trouble in the kidney, while the urine contains blood or pus, and there is a raised temperature, or if anuria be present, operative

CORAL-SHAPED CALCULUS LYING IN PELVIS OF KIDNEY.

(Museum, Queen's University of Belfast.)

[To face page 620.

procedure should be undertaken. According to the condition of things found, the operation will be either *nephrolithotomy*, *nephrotomy*, or *nephrectomy*.

Fullerton reports a case in which a calculus became impacted in the lower part of the ureter, and was removed from that position by means of a pair of curved forceps passed through the bladder by the aid of the cystoscope.

TUMOURS OF THE KIDNEY.

General Characteristics of Kidney Tumour.—A kidney-shaped swelling with a notch on its inner border and a rounded external border, occurs at the situation of the kidney in the loin. On palpation dulness is elicited. At first there is resonance in front, owing to the presence of the colon, which, however, ceases as the tumour becomes enlarged, owing to the bowel becoming displaced. It is sometimes difficult to differentiate liver and tumour dulness.

Varieties of Kidney Tumours and Cysts.

Simple.			Malignant.	
Cystic disease.	Papilloma.	Adenoma.	Sarcoma.	Carcinoma.

Simple Tumours.—Cystic Disease (polycystic kidney, cystic degeneration of the kidney) is a cyst development in the substance of the kidney, due to persistence of the **mesonephros** (Wolffian body). The cysts are lined with epithelium, and are filled with limpid fluid containing urea. When the condition is congenital it may interfere with the birth of the child ; in later life it leads to polycystic degeneration.

Symptoms.—The disease usually runs a very chronic course, but death may occur suddenly from uræmia or cerebral hæmorrhage. When the disease is first discovered, there is usually found a tumour of considerable size in the region of each kidney. If only one kidney is enlarged, as sometimes occurs, diagnosis is rendered very difficult. At the same time the liver may be enlarged, and cysts may be felt on its anterior surface. Polyuria may be present; the urine is largely increased in amount, is pale, and of low specific gravity. Albumin, blood, and tube casts, may be present. Colloid bodies concentrically laminated, when present in the urine, are said to be diagnostic.

Diagnosis.—This has to be made from renal tumour, malignant or otherwise. In cystic disease the condition is bilateral, while hepatic cysts are usually also present, and the urine, as stated above, is copious, of pale colour, and low specific gravity. The blood-pressure is raised.

Treatment.—Operative procedure is of no benefit, but patients may continue to live for a long period without radical treatment.

Solitary cyst also occurs in young children, and sometimes in adults. It arises in the cortex or one of the poles, and grows as a rule without producing symptoms till it is observed as an abdominal tumour, which may be mistaken for a distended colon, hydronephrosis, or an ovarian cyst. If possible, the cyst should be removed by dissection,

leaving behind healthy renal tissue. Sometimes, however, the pressure of the cyst has reduced the whole organ to a thin-walled sac containing clear fluid. The pedicle of this should be tied and the sac removed.

Papilloma.—This is a rare condition, in which a tumour similar to the papillomata of the bladder grows in the pelvis of the kidney. It occurs **without much local swelling of the kidney.** Hæmaturia is a prominent symptom, and is excessive in amount. If the growth block the ureter, neither urine nor blood will pass.

If the condition cannot be otherwise diagnosed, an exploratory operation should be undertaken to relieve symptoms, and if a growth is found, the kidney should be removed, as malignancy is to be feared.

Adenoma and Other Tumours of the Adrenal Bodies.—Adenomata are supposed, from their structure, to be growths from accessory adrenals or misplaced kidney substance. They should be removed, as a rule with the kidney if the condition is diagnosed.

When tumours of the adrenal bodies occur in children, they are usually composed of tissue which resembles the cortical part of the gland, and are called **hypernephromata**. Grawitz believed that they were formed of suprarenal tissue; Stoerk believes them to be papillomatous; Wilson and Willis have recently shown that they spring from the Wolffian body. They are sometimes associated with pigmentation of the skin and premature development of the sexual organs. In adults adrenal tumours are commonly of a malignant nature, usually sarcomatous.

Symptoms.—There are commonly no signs of the condition till a tumour is observed in the loin, and the disease may then be too far advanced for operative interference. In some adult cases there is an early failure of health, and anæmia is a marked symptom, while pain may be present and be referred to the thigh and testes. Hæmaturia may be present if the growth burst through into the pelvis of the kidney, and may again cease owing to blocking of the ureter. The urine from the diseased kidney is of lower specific gravity than normal, and blood may be observed coming from the ureter in some cases. Occasionally a varicocele is found on the affected side.

The **Prognosis** is not good unless hæmaturia has indicated a diseased organ at an early stage.

Treatment.—Removal of the kidney if diagnosis is made.

Malignant Tumours—Sarcoma.—This may develop in infants or in adults. In the former it may be congenital, or may be acquired soon after birth. The tumour, which is round or spindle-celled, grows to a large size, and both organs may be affected. **Neither hæmorrhage nor pain is as a rule present** till the tumour has reached large proportions. Death occurs from obstruction to circulation, as by an *embolus*, or from general dissemination. Operation is contra-indicated unless for the relief of symptoms.

In adults the disease occurs at from thirty to fifty years of age. The tumour is of the spindle-celled variety, and grows rapidly. **Pain and bleeding are marked symptoms.** Calculi are frequently found in the pelvis of the kidney. Secondary deposits take place in other viscera. Nephrectomy should be performed, but the prognosis is not good.

PLATE LXIX.

CYSTIC DISEASE OF KIDNEY.

(Museum, Queen's University of Belfast.)

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Carcinoma.—The symptoms generally are like those of sarcoma, but one special characteristic of the disease should be remembered—*i.e.*, there is often a varicocele present, due to pressure of the affected glands on the root of the spermatic veins; hence, **whenever an old man develops a varicocele, suspect cancer of the kidney.**

If diagnosed early, the kidney should be removed.

RENAL PARASITES.

1. **Hydatid Cyst.**—Due to the embryo of *Tænia echinococcus*, may grow under the capsule or in the substance of the kidney, and may destroy the structure of the organ, burst into the pelvis, and pass along the ureter to the bladder.

Diagnosis.—This is very difficult. If no cyst matter be passed, an exploratory incision is usually required to clear up the case. Occasionally the cyst breaks into the lung.

Treatment.—Enucleate and drain, or if the kidney has been much injured, remove the organ.

2. **Eustrongylus Gigas** is rarely found in man, though common in the lower animals. When present, it is in the pelvis of the kidney, and causes dysuria, hæmaturia, chyluria, and pyuria.

3. **Distoma Hæmatobium** (*Bilharzia hæmatobia*) is uncommon in this country, but is met with in those who have been in Egypt. It gains entrance by food or water, and travels to the kidney. The symptoms of its presence are hæmaturia and occlusion of the bloodvessels. An otherwise inexplicable hæmaturia in one who has been in Egypt should lead us to suspect the presence of the organism.

4. **Filaria Sanguinis** is indigenous to the Indies and Egypt. It causes occlusion of the lymph vessels, and lymph from accessory channels finds its way to the kidney, giving rise to hæmaturia and chyluria.

SYPHILITIC DISEASE OF THE KIDNEYS.

This disease may attack the kidneys as a diffuse bilateral interstitial nephritis, and is indicated by both kidneys secreting albuminous urine. A gummatous growth may attack one kidney only.

The history of syphilis and the effects of antispecific treatment are the principal methods of diagnosis.

Antisyphilitic treatment should be adopted. Operation is contra-indicated.

KIDNEY AND URETER.

Injuries to the Kidney.—The kidneys are injured by direct or indirect violence, and may be penetrated in fracture of the eleventh and twelfth ribs, or the eleventh and twelfth dorsal, or the first and second lumbar vertebræ. Injury to the kidneys is often produced by crushes, as between buffers, or by a heavy weight passing over or falling on the abdomen. Rupture may be produced by a kick from behind, as in playing football. Bleeding is usually severe, but if the capsule be not torn, it is limited and extravasation prevented. The bleeding may be intra- or extra-peritoneal. If the former, a con-

siderable amount of free fluid is present in the peritoneal cavity, and may produce fatal results. When extraperitoneal, an abscess may be formed in the retroperitoneal cellular tissue. The connection between injury to the kidney and kidney disease must be remembered, for there can be little doubt that nephritis and albuminuria may follow an injury, and chronic Bright's disease be established.

Altogether apart from direct injury to the kidney, disease of that organ may result from various injuries to and diseases of other parts of the urinary tract.

Symptoms.—Severe shock; frequency of micturition, the urine being mixed with blood; pain over the kidney and passing down into the thigh and to the testicle.

The bleeding may be so severe as to threaten life. The bladder is often filled with clots, one or more of which may obstruct the ureter, or may give rise to renal colic during the passage of the duct.

Treatment.—Rest; an ice-bag or strapping to the loin; internally, ergot, tannic acid, or adrenalin. If bleeding persist, an exploratory operation must be undertaken, and the case dealt with as circumstances demand.

Injury to the Ureter.—This is not a common accident, but rupture may occur from direct violence or from a deep penetrating wound. If the injury be subcutaneous, it is very difficult to recognize, but catheterization of the ureter will show that no urine is passing into the bladder, and later on extravasation will result in the formation of a perinephritic abscess. Occasionally the condition is only discovered when this abscess is opened, and on exploration the tear of the ureter is seen.

Division of the ureter during an operation is not an uncommon accident, and is sometimes overlooked. The divided ends should at once be sutured.

DISEASES AND INJURIES OF THE BLADDER.

The student should remember that the bladder is the half-way-house of the urinary system, in which is stored for a time the excretion of the kidneys, conveyed to it by the two ureters, the orifices of which are situated at the base of the trigone; and finally discharged through the urethra. It will at once be seen that abnormal urine may be discharged from a healthy bladder, the condition being due to disease of the kidneys; while, on the other hand, normal urine may be received by the bladder from healthy kidneys and discharged as abnormal, owing to the diseased state of the bladder. If, however, unhealthy urine be passed into the bladder for a prolonged period, that organ will eventually become inflamed, and the disease itself may pass downwards from the kidneys. Infection may also be conveyed in a contrary direction, and the kidneys become involved by the passing up of infection from the bladder.

The importance of the cystoscope will be appreciated in deciding which organ is responsible for the infected urine; for if the bladder be washed out, its coats can be examined for signs of disease, and the

orifices of the ureters watched to ascertain the nature of the urine entering, and the ureters can also be catheterized to ascertain by examination the character of the urine, and whether micro-organisms are present. The student must not imagine that it is quite a simple matter to decide if a bladder is healthy or not, and to pass a ureteral catheter requires both skill and experience.

Let it be remembered that the bladder is in its empty condition a pelvic organ, and when distended partly an abdominal one, and also that on its upper and back portions it is covered by peritoneum, while its lower and front portions are free from such covering. It will then be understood how an injury with possible extravasation may be intra- or extra-peritoneal, and so differ in its seriousness and prognosis.

CONGENITAL CONDITIONS.

Certain congenital affections are met with, but they are not common.

Extroversion of the Bladder (Ectopia Vesicæ).—This condition is characterized by an absence of the front wall of the organ and certain bony defects, as the absence of the symphysis pubis, the shortening of the horizontal ramus of the pubic arch, an outward rotation of the innominate bones, and a convex instead of concave sacrum. The anterior covering of the penis is also wanting (epispadias), and there is a protrusion of the posterior bladder wall.

Treatment.—All sorts of apparatus have been designed for this condition, none of which are very serviceable.

Operative procedure is difficult. The methods are—

1. The division of the sacro-iliac ligaments from behind and the compression of the lateral halves of the pelvis so as to make the posterior wall of the bladder recede and form a hollow, which is covered by a plastic operation (Trendelenburg).

2. A flap operation by which the anterior abdominal wall is turned down to form the anterior bladder wall. The objection to this is that the hairs which later on grow on the flap lead to concretions being formed, and a better method is to undercut the abdominal wall and slide it as far as possible, skin-grafting the remaining uncovered surface.

3. The transplanting of the ureters into the bowel, so that the urine thereafter is discharged through the anus. This method of dealing with the condition has in its favour the overcoming of incontinence, which remains after the former operations. The extroverted bladder may then be closed or left alone, as in time the mucous membrane afterwards hardens and has the appearance of skin.

4. Bergenhem and Peters insert the ureters into the rectum extra-peritoneally ; the patient is then able to void his urine at will. Except in the morning, when it is mixed with fæcal matter, it is usually clear when passed.

5. Maydl transplants the part of the bladder wall containing the orifices of the ureters to the bowel, thus preserving their valvular action and preventing to a great extent infection of the kidneys from the bowel.

Umbilical Urinary Fistula.—If the urachus does not close properly, this condition is produced. The urachus should be dissected out and the opening at the bladder sutured.

ACQUIRED CONDITIONS.

Cystitis.

Inflammation of the bladder may be acute or chronic.

Acute Cystitis.—This condition is caused by (1) traumatism by means of foreign bodies; (2) external or internal violence; (3) gonorrhœa by extension from the posterior urethra; (4) irritating poisons, as cantharides; (5) sepsis; (6) chill; (7) certain spinal lesions.

The organisms concerned are—Pyogenic cocci, *Proteus hanseri*, *Diplococcus ureæ*, or *Bacillus coli*, in women owing to direct infection from the rectum. When the last-named organism is present, the urine remains acid; in the presence of the others it is alkaline. The gonococcus may also be responsible for the condition.

Symptoms.—There is a considerable amount of feverishness; pain referred to the perineum, which is made worse on attempting to pass water; tenderness over the symphysis; strangury; the urine contains pus, blood, and many bacteria, and is alkaline in reaction. Recovery is the rule, but the condition may become chronic or death result from exhaustion, peritonitis, or by the disease extending to the kidneys and setting up suppurative pyonephrosis.

Treatment.—The patient should be kept in bed, and fomentations applied over the bladder. Any causative factor should be removed or treated. Plenty of fluid nourishment should be given. Of drugs, boric acid (10 grains every three hours in milk), urotropine (5 grains thrice daily), or salol (5 grains every four hours) are the best in the order stated, while morphia suppositories may be given to relieve pain.

Chronic Cystitis.—This results from some form of constant irritation to the walls of the viscus, as from stone, foreign body, and tumour, or from the retention of foul urine or the presence of some disease of the walls, as tuberculous ulceration. It may also follow the acute variety or be one of the symptoms of spinal injury from interference with the nervous supply of the organ.

Symptoms.—Constant pain and irritability of the organ, with frequent desire to pass water. The urine is alkaline and foul, and contains pus, phosphates, and epithelial cells, together with a variety of organisms. Constitutional symptoms become marked if the disease persist, and extension to the kidneys may take place.

Treatment.—Remove the cause; give similar drugs to those recommended for the acute variety. If the case persist, the bladder should be **irrigated** with ¼ per cent. solution of protargol or silver nitrate, by means of a rubber tube attached to a glass cylinder into which the solution is poured, the bladder being first washed out with saline solution. The organ should not be distended; 2 or 3 ounces is sufficient to put in. If the silver salts prove too irritating, boric lotion (10 grains to 1 ounce) or permanganate solution (1 in 5,000) may be substituted. The bladder should be *irrigated* once daily.

Guyon recommended **instillation.** In this procedure a syringe attached to a small bone catheter injects into the bladder 15 to 30 minims drop by drop of a strong solution of silver (1 to 5 per cent.) or perchloride of mercury (1 in 5,000). This is done every second, third, or fourth day.

In some persistent cases it may be necessary to drain the bladder by means of perineal cystotomy.

Tuberculosis of the Bladder.

Tuberculous affections of the bladder may be primary or secondary, usually the latter, extending from kidney, testis, or prostate. It is met with most frequently in men.

The multiple ulcers which result from the breaking down of the tubercles are usually found near the **trigone.**

Symptoms are those of chronic cystitis. Hæmaturia and irritability of the bladder are marked symptoms.

Diagnosis.—This can be made by the demonstration of the tubercle bacillus in the urine, by coexisting tuberculosis of other organs, and by the appearance of the bladder when examined by the cystoscope. The surface looks as if studded with follicles, at first grey, then yellow in colour. When these break down, ulcers can be seen, which are usually ragged in outline, and are either small or, when several have joined, large and irregular.

Prognosis is not good, extension occurring if the disease be primary and general exhaustion from dissemination if secondary. Occasionally good results follow treatment.

Treatment.—Remove or treat the original focus of disease. Do not wash out the bladder. Carry out general hygienic and dietetic treatment. Drainage of the bladder by the suprapubic route gives good results, and through this wound the ulcers may be scraped if thought advisable. Of drugs, morphine is the most useful, while tuberculin has been found of benefit in some cases.

Simple Ulcer of the Bladder.

This is fairly common according to Fenwick. Its position is near the neck or trigone, and gives rise to very similar symptoms to those met with in tuberculous ulcer.

The **Diagnosis** is best made by the absence of tuberculous disease in other parts of the genito-urinary tract and of the tubercle bacillus from the urine, and by the appearance of the bladder on cystoscopic examination. A phosphatic deposit sometimes takes place over the ulcerated surface, giving the impression that a stone is present.

Treatment.—Wash out the bladder with lactic acid (1 per cent. solution), and if symptoms persist scrape the ulcerated surface through a suprapubic opening.

Tumours of the Bladder.

These may be simple or malignant ; the simple are the more usually met with.

Papilloma (Villous Tumour).—This is the most common. It occurs as a soft flocculent mass situated near the trigone, and usually close to the opening of one or other of the ureters.

Symptoms.—Recurrent profuse hæmorrhage of a bright red colour. Irritability of the bladder induced by chronic cystitis. When the urine has undergone alkaline changes, there is an abundant secretion of ropy mucus. Portions of the tumour may be found in the urine. Urination may be interfered with by some of the fibrillated ends of the tumour being swept into the urethra. The ureters may be encroached upon by the growth and *hydronephrosis* thus produced.

Examination by the sound gives no definite information, unless, as

sometimes happens, the surface of the growth becomes encrusted with phosphates. On cystoscopy, " their plastic effect on the field of vision is enhanced in most cases by a floating about of papillomatous shreds or tufts in the bladder fluid. . . . The sharp reflex light causes the ends of the papillomatous tufts to appear, commonly, white with a tint of delicate rose " (Rumpel).

Prognosis.—The growth may lead to a fatal termination by becoming malignant or by profuse hæmorrhage. If treated efficiently, the results are good.

Treatment.—To relieve hæmorrhage, rest, with injection of ergotine and suprarenal extract may be tried, and if inefficient 2 or 3 ounces of nitrate of silver (1 in 1,000) should be injected into the empty bladder.

Through a suprapubic opening dissect out the growth with the mucous membrane from which it springs. Casper advises its removal by means of an operating cystoscope when the growth is favourably situated.

Sarcoma.—This is unusual in the bladder. It is more common in children, in whom the growths are multiple, while in adults the disease exists as a single tumour.

The lymphatic glands are frequently implicated early in the course of the disease.

Treatment.—Removal, with, if necessary, a piece of the bladder wall through a suprapubic opening. In many cases operative interference is impossible.

Carcinoma.—The disease may originate in the bladder or be secondary. When primary, the type is squamous epithelioma ; when secondary, the original type is followed. The condition is most common in men. The usual position is the posterior wall above the trigone.

Symptoms.—The first symptom is usually a severe attack of pain, followed by bleeding. The symptoms of cystitis are usually present, and dysuria with severe pain, which is referred to the perineum.

If a sound be passed, the tumour is felt as an irregular mass projecting into the bladder. Perforation of the posterior bladder wall may occur.

Diagnosis.—Cystoscopic examination will help diagnosis, while shreds of the growth may be discovered in the urine.

When hæmorrhage is associated with marked vesical irritation and cannot be otherwise explained, a tumour may be suspected.

In simple tumour the hæmorrhage, which is usually severe, **precedes the pain.** Examination by sound and *per rectum* as a rule reveal nothing.

In malignant tumour pain, which is severe, **precedes hæmorrhage.** Examination by sound and *per rectum* reveals a tumour.

This rule is, of course, not without exception, and applies to carcinoma rather than to sarcoma.

Treatment.—When the disease is localized, removal is to be attempted through a suprapubic opening. The involved part of the bladder wall should be removed with the growth. When the case is inoperable, symptoms may be relieved by suprapubic drainage, or by dividing the ureters and bringing them to the surface in the region of the loin.

This remarkable specimen shows a large phosphatic stone lying in the bladder, the walls of which are hypertrophied. The ureters have also become considerably dilated.

(Museum, Queen's University of Belfast.)

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The transperitoneal route is often indicated, especially for growths on the superior and anterior walls of the bladder. Fullerton says of this route that in his experience "the method of transperitoneal cystotomy is one which gives an excellent view of the interior, and enables operative measures to be carried out with much greater care than any other method. The patient should be placed in the Trendelenburg position, an incision made for 6 inches in the middle line, the intestines packed away with gauze, the bladder hooked up on both sides, and opened by a vertical incision."

Vesical Calculi.

If formed in the kidney, and afterwards discharged into the bladder, the calculus is termed **primary**; if formed in the bladder, **secondary.** The former are usually composed of uric acid or oxalate of lime, the latter of phosphates and carbonate of lime deposited upon a foreign body.

Characteristics of the various stones:

	Uric Acid.	Oxalate of Lime.	Phosphates.
Colour	Light or dark fawn from pigmentation	Dark brown from blood	Greenish-white
Character	Smooth and regular; brittle	Tuberculated "mulberry stone"; hard and dense	Soft
Size	Various	Small	Large
Weight	Heavy	Very heavy	Light
Nucleus	Uric acid	Oxalate	Uric acid or foreign body
Origin	Renal	Renal	Vesical

Urinary calculi, though often composed of the same material throughout, are sometimes alternating or mixed in formation. Thus a uric acid stone may be deposited in the bladder; the urine is alkaline, and become covered with phosphatic deposits.

The most usual nucleus is one of uric acid, next in frequency one composed of oxalates, and least frequently one of phosphatic origin.

The nucleus of a phosphatic stone is sometimes formed by a piece of catheter or other foreign body left in the bladder; at other times of pus, mucus, or blood.

An oxalate of lime nucleus usually has a body of the same, but may be encrusted with phosphates.

A uric acid nucleus usually has a body of the same, but may be encrusted with oxalates or phosphates.

A phosphatic nucleus always has a body of the same.

The accompanying illustrations are taken from photographs kindly lent by Dr. Johnstone, and show vesical calculi removed by him at the Church Missionary Society's Hospital, Baghdad.

Position of Vesical Calculus.—Usually behind the prostate or on the trigone. If encysted, it is usually in the posterior wall.

Number.—From one to thousands.

Causation.—Constitutional conditions predisposing to lithiasis or

oxaluria. Composition of drinking-water. Common in tropical countries, possibly owing to profuse perspiration. In many places in this country stone is almost an unknown disease. Common during first and sixth decades. In the former period, especially among the lower classes, when oxalate stones are usual; in the latter, among the rich, the stones generally being composed of urates.

Symptoms.—There is as a rule a history of having passed gravel, which has ceased. Pain occurs in the perineum and the neck of the bladder, radiates to the back and down the thighs, and is especially referred to the tip of the penis after the act of micturition, which is frequent. Hæmaturia, in most cases, is not marked. There is increase of the symptoms on taking exercise. Sudden stoppage of the flow of water during micturition sometimes occurs. Hernia may be produced by straining in those congenitally predisposed to its formation. Tenesmus with production of piles. Priapism. Wetting of the bed in the case of children, in whom phimosis is often present. Chronic or acute cystitis, when the symptoms will be present independent of rest or exercise.

Stone is fairly common in boys, but not frequently met with in women, probably owing to the fact that small calculi can be passed by the female urethra and that they are not prone to chronic cystitis.

Diagnosis should be made by means of passing a sound, or by cystoscopic examination, or by both combined. Since the perfecting of the cystoscope the use of the sound has been dispensed with to a great extent.

When sounding, the bladder should be examined in some regular order or the stone may escape detection.

It sometimes happens that the symptoms of stone are complained of by a hysterical subject, when no such disease is present. Cystoscopic examination will clear up the diagnosis.

If the case remain untreated, the urine will become septic from chronic cystitis, the bladder hypertrophied, and its mucous membrane ulcerated. The inflammation may extend to the kidneys, producing pyelitis, pyelonephrosis, or pyonephrosis. There may be a fatal termination from septic or uræmic poisoning.

Treatment.—Once a stone has formed, some operative procedure must be adopted for its removal. The choice lies between a crushing or a cutting operation.

Lithotrity.—For many years past the crushing procedure has been gaining in popularity, and its limitations removed by improved technique and instruments, and it may now be said that unless specially contra-indicated it is the procedure of choice.

Bigelow's operation consists in passing a lithotrite (No. 16 to 20) into the bladder, in which 6 ounces of boric lotion is left after irrigation. When the blades of the instrument are opened at the most dependent part of the bladder, the stone may fall between them; otherwise it must be searched for. They are then locked and the stone crushed by the screwing action. The fragments are in turn crushed, and the lithotrite withdrawn. The evacuating tube is now inserted, and the fragments pumped out by means of the evacuator.

When the lithotrite will not pass, the membranous urethra may be opened on a staff, and the instrument introduced through the wound (perineal litholapaxy, Keith).

The after-treatment is of importance. The patient should be kept quiet and warm, shock should be combated, and a fluid diet adopted

URIC ACID VESICAL CALCULUS, REMOVED BY SUPRAPUBIC CYSTOTOMY.

MIXED URIC ACID AND PHOSPHATIC VESICAL CALCULI, REMOVED BY LATERAL LITHOTOMY.

Patient suffered from marked cystitis with foul urine. Note the facets on the calculi produced by pressure.

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PLATE LXXII.

URIC ACID VESICAL CALCULUS WITH CORTICAL LAYER OF PHOSPHATIC MATERIAL.

Removed by lithotrity with Neve's modification of Harrison's lithotrite inserted through lateral lithotomy wound. The patient suffered from a stricture of the urethra.

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for some days. Pain should be relieved by a little morphia, and if all goes well the patient is allowed up at the end of a week.

Certain sequelæ may take place: they are **cystitis, atony** of the bladder, and **urinary fever,** and these unfortunate results cannot always be guarded against.

Lateral Lithotomy is one of the three cutting operations for the removal of stone, and has certain advantages.

A laterally-grooved staff is used as a guide to the knife entering the bladder, and the stone is removed through the perineal opening.

Median Lithotomy is performed with a medianally grooved staff for guide. The instrument differs from a Syme's staff in not having a shoulder and in the point not tapering. It is applicable only for the removal of a small stone.

Suprapubic Cystotomy is the operation preferred by some surgeons to any other, and is probably preferable to either of the other cutting operations.

Choice of Operation.—Lithotrity should be chosen unless contra-indicated by the following circumstances:

1. **Conditions of the Stone.**—(*a*) If it exceeds 1½ inches in size, this is not an absolute contra-indication. (*b*) If it is very hard. This may be overcome by a powerful lithotrite. (*c*) If it is very soft. (*d*) If it is encysted.

2. **Conditions of the Urethra.**—(*a*) Existence of organic stricture. (*b*) Enlarged prostate, which obstructs the urethra, and is to be dealt with at the same time. (*c*) False passages.

3. **Conditions of the Bladder.**—(*a*) Excessive irritability. (*b*) Cystitis. (*c*) Sacculated organ. (*d*) Contracted organ.

The choice has to be made now between lateral and suprapubic lithotomy.

Indications for Lateral Lithotomy.—1. In cystitis and great bladder irritability the lateral operation will facilitate drainage and washing-out.

2. A contracted and hypertrophied bladder.

Indications for Suprapubic Lithotomy.—1. When the stone is too large and rough to be removed by the perineal route, or to be crushed with modern crushing instruments and technique. A stone, however, is seldom met with too large for lithotrity.

2. Encysted stone.

3. Where there is a stricture of the urethra or an enlarged prostate.

4. In certain pelvic conditions, as—

(*a*) Rachitic contraction.
(*b*) Tumour.
(*c*) Ankylosed hip-joint.

It is hard to imagine any real **contra-indication** to suprapubic lithotomy unless it be—

(*a*) Severe septic cystitis.
(*b*) Much contracted bladder.

In children lithotrity is the operation of choice for stone, using instruments of a suitable size.

Stone in women is dealt with in the following chapter.

Parasites of the Bladder.

It is not common to find parasites in the bladder in this country except in those who have been abroad.

Bilharzia Hæmatobia (*Distoma hæmatobium*). — The parasite is called after Bilharz, the discoverer of the organism. It is sometimes found to be the cause of otherwise inexplicable hæmaturia in those who have lived in Egypt, where the infection is common. It is a trematode parasite, the embryos of which live in water, on drinking which the organism gains access to the digestive tract. From there it is believed it passes along the portal vein, and thence through the vesical veins into the bladder. The organism has a cylindrical body with rounded ends, and measures 1 centimetre in length.

Symptoms.—Frequent considerable hæmaturia, strangury, and pain. The urine is turbid owing to the presence of pus. The symptoms may entirely abate, leading to the supposition that the disease is cured, only to return with increased severity.

Treatment.—To remove the cause is wellnigh impossible, so treatment is chiefly directed to checking hæmorrhage, for which purpose injections of caustics, such as silver nitrate (1 in 1,000), may be tried.

Filaria Sanguinis Hominis.—One of the trematodes found chiefly in Egypt, but met with in most tropical countries. The microorganisms are round sinuous bodies enveloped in a capsule. The parasites enter the kidneys, and give a whitish appearance to the urine owing to the rupture of lymphatic vessels by the organism in the bladder ; the urine also sometimes contains blood.

Symptoms.—The organism travels to the bladder, and there sets up inflammation, giving rise to pain, strangury, hæmaturia, and retention of urine.

Treatment.—Largely climatic. When no fresh infection takes place, the ova are passed from the bladder, and a cure takes place.

Echinococcus Hominis.—The organism reaches the bladder from the kidney, or sometimes through the tissues from the pelvic cellular tissue.

Symptoms.—Largely those of cystitis, from which the disease is to be distinguished by finding cysts or hooklets in the urine, or by cystoscopic examination.

Treatment.—The only satisfactory treatment is to seek for the parent cyst and to remove it.

FUNCTIONAL DERANGEMENTS.

Incontinence.

1. **Active Incontinence** occurs in young people, boys especially, as the result of some irritative condition of the urinary apparatus, such as a tight foreskin, worms, polypus, or urine of high specific gravity. It usually occurs at night.

Treatment.—Remove any possible cause that may exist to provoke the condition, regulate the diet, which should be simple, keep the bowels and bladder freely and regularly emptied. Tonics should also be administered.

2. **Passive Incontinence** usually occurs when the neck of the bladder is relaxed owing to—

(1) Paralysis of the sphincter vesicæ.
(2) Injury to the cord at the centre for urination or above it.
(3) Impaction of a calculus or other body in the internal meatus.
(4) A pedunculated growth of the prostate.

Treatment.—For (1) and (2) nothing curative can be done. Where the cause is mechanical it should be removed.

3. **False Incontinence** arises from distension of the bladder with overflow of its contents due to spinal injury, neglected stricture or enlargement of the prostate.

Atony of the Bladder.—This is a condition in which the patient is unable to expel the contents of the viscus owing to —

1. Acute voluntary overdistention, arising from any circumstance. Atony from this cause is as a rule merely momentary, but may be more serious.

2. Chronic overdistention, due to enlarged prostate or to stricture, in which the amount of residual urine gradually increases till it fills the bladder.

3. Sometimes occurs as a result of cystitis.

4. It is occasionally met with in old age.

5. Occasionally results after operation, owing to the retention common after interference with the genito-urinary system or rectum, when unrelieved by the passage of a catheter.

Treatment.—Removal the mechanical cause if any exist; massage; the administration of such tonics as strychnine and phosphorus. Regular catheterization should be employed for some time in order that distension may not take place.

Retention of Urine.

The cause of retention may be referable to bladder, prostate, or penis, to extraneous pressure, or to some constitutional cause.

1. **Vesical Causes.**—Tumours, stone, paralysis, or atony.

2. **Prostatic Causes.**—Hypertrophy, prostatitis, tumour.

3. **Urethral Causes.**—Occlusion of the canal, impacted calculus, stricture, abscess, constricting band or phimosis.

4. **Constitutional Causes.**—After genito-urinary irritation; hysteria, especially in women.

5. **Pressure Causes.**—From tumours in neighbouring organs.

If unrelieved, grave results will follow; the urethra behind the obstruction or the bladder wall may burst, leading to extravasation of urine.

Treatment consists in removing the cause of the symptom and treating the constitutional condition.

THE URINE.

The table on p. 634 gives the description and analysis of the excretion of the kidneys of a healthy person in twenty-four hours.

Examination of the Urine.—The **amount** is ascertained by collecting all the urine passed in twenty-four hours.

The **colour** is best determined by filling a long glass and holding it to the light.

The **reaction** is tested by means of blue and red litmus paper, acid urine turning the former red and alkaline urine turning the latter blue. Unless the alkalinity can be accounted for by a largely vegetable diet, it must be looked upon as abnormal, and usually arises from ammoniacal decomposition, when the vapour will be sufficient to discolour the paper. It may, however, be due to the presence of fixed alkalies, in which case the vapour will not alter red litmus paper.

Amount	**50 ounces or 1,500 c.c.** Profuse sweating or drinking large quantities of fluid will **temporarily** alter the amount.
Colour	**Amber.** May be almost colourless or deep brown, according to amount of concentration.
Reaction	**Acid.**
Specific gravity	**1020.** It may vary from 1015 to 1025, and depends upon the proportion of solids to amount of fluid.
Odour	**Faintly aromatic.**
Water	**1,440 grammes.**
Urea	**35.**
Uric acid	**0·75.**
Sodium chloride	**16·5.**
Phosphoric acid salts ..	**6·0.**
Sulphuric acid salts ..	**3·0.**

The **specific gravity** is tested by means of a urinometer, which floats in the urine and is read off at the point where the stem rises from the fluid. Care should be taken to avoid reading it off where the urine adheres to the glass instead of at the true level at the top of the fluid.

The **odour** can be detected in the usual way.

The amount of **solids** in the urine may be measured by multiplying the last two figures of the specific gravity by Hæser's coefficient—*i.e.*, 2·33.

Having estimated the solids, the amount of **water** will be the total of the urine less that amount.

Albumin in the urine may be temporary or permanent.

In the former case it results from excess of some particular diet or from emotional causes, and disappears again. If permanent, it is due to some affection of the kidneys, either local as in Bright's disease, or part of a general condition as in lardaceous changes. It is usually present as serum-albumin or serum-globulin.

Tests—1. **Heat Test.**—When boiled, the urine, if it be acid, becomes turbid, which may, however, be due to the presence of phosphates. To ascertain this a few drops of weak nitric acid are added, when the turbidity due to phosphates disappears, while that due to albumin is unaltered. If the urine be alkaline, a few drops of nitric acid will be required to precipitate the albumin in the *boiled* urine.

2. **Ring Test.**—Pour some of the urine to be examined into a tube and add a small quantity of fuming nitric acid, poured down the side while the tube is held in a slanting position ; allow a few moments to elapse before holding the tube upright, when a white ring will be noticed to have replaced the normal faint brown one at the junction of the two fluids. The acid may be first put into the test-tube and the urine added very slowly. Great care must be taken to avoid admixture of the fluids.

3. Quantitative Test.—By means of Esbach's albuminometer. Fill the test-tube to U with urine, and fill up to R with Esbach's solution (picric acid, 10 grammes ; citric acid, 20 grammes ; water, to 100 c.c.). Reverse the tube once or twice, and then allow it to stand for twenty-four hours, when the amount of albumin may be read off on the scale. This indicates the parts per litre. Divide by ten to give the percentage.

4. When the amount of albumin is very small, a few drops of acetic acid should be added to the urine, and then some drops of potassium ferrocyanide (10 per cent.). This will throw down a flocculent precipitate, or if the amount of albumin present is still smaller, it will cause a turbid condition.

FIG. 109.—ESBACH'S ALBUMINOMETER. (Casper.)

Sugar.—Sugar in the urine usually indicates the presence of **diabetes mellitus,** but it should never be forgotten that sugar may be present owing to excess of saccharine diet, or may be a temporary excess of the trace of glucose normally found in the urine, and have no pathological significance.

Tests—1. **Fehling's** (from Faylingz, a German chemist). — Fehling's solution consists of 0·034 gramme of cupric sulphate added to an alkaline tartrate. They may be kept separate, or even better in tabloid form, thus preventing the deterioration of the reagent. The test depends on the reducing power of glucose on copper, producing a brown-coloured precipitate.

To a small quantity of Fehling's solution add a few drops of the suspected urine and boil. There may now be a yellow to red precipitate if a considerable quantity of sugar be present. If there be no change, add an equal quantity of urine to the solution, and boil. If there be no coloration, set aside, and if on cooling there is still no precipitate, sugar may be held to be absent from the urine.

2. **Trommer's.**—To a portion of suspected urine add one-eighth of its volume of caustic potash and 1 per cent. of sulphate of copper. If sugar be present, the solution is coloured blue. Continue to add copper sulphate and boil the upper part of the fluid, when a yellow to red colour is produced.

3. **Moore's.**—Add to a portion of urine one-third of its volume of concentrated potassium hydrate, and boil for a few moments, when, if sugar above 0·5 per cent. be present, the solution will turn from light yellow to deep brown, according to the amount of sugar present.

Blood.—The urine may contain blood owing to a variety of causes, which may be divided into renal, vesicular, prostatic, urethral, and constitutional.

1. **Renal,** due to acute inflammation, calculus, tumour, or traumatism. Blood-casts of renal tubules may be present. **The urine is deeply coloured and intimately mixed with blood.**

2. **Vesicular**, due to calculus, tumour, traumatism, or *Bilharzia hæmatobia*. **The urine is mixed with the blood, but it is more abundant at the end of micturition, and clots are often present.**

3. **Prostatic,** due to calculus, acute congestion, malignant disease. The organ should be examined *per rectum* in all doubtful cases, since the blood usually passes back into the bladder and so simulates disease of that organ.

4. **Urethral,** due to gonorrhœa or traumatism. The blood may flow away independently of the act of micturition, while the **first part of the flow is highly coloured, or may be pure blood.**

5. **Constitutional,** due to purpura, scurvy, or hæmophilia. This is rare, and other signs of the disease present will help diagnosis.

Test.—Add a few drops of tincture of guaiacum and ozonic ether to the urine and shake well, when a blue colour will be given to the ether, which rises to the top of the test-tube.

Bile Pigment.—Bile pigment is present in the urine during an attack of **jaundice.** If present in large amount, the urine is green in colour, and has a green foam when shaken, which distinguishes bile-tinted urine from drug coloration, as by rhubarb and senna.

Tests—Gmelin's (Gmelinz, a German chemist).—This consists of the play of colours produced at the point of contact of the bilious urine and nitric acid. It may be carried out by pouring the urine on to the acid in a test-tube or by allowing the two fluids to meet upon a piece of test paper. In either case the coloration is green to violet, violet to red, red to yellow.

Pus.—Pyuria is a symptom of some inflammatory condition of the urinary tract, and may come from any part of the passage.

Tests.—Add liquor potassæ to the urine, and pour from one test-tube to another, when it will become ropy.

Microscopically pus cells are recognized by the presence of nuclei, especially if acetic acid be added.

Fat in the urine is due to chyluria from rupture of the lymphatic vessels of the bladder by the action of the *Filaria sanguinis hominis*, or to **lipuria** from rich diet.

The urine is milky in colour.

Tests.—Add potassium hydrate and ether: cloudiness disappears. Evaporate a drop of the mixture on a piece of white paper: a spot of grease will remain, which does not disappear on heating.

Microscopically fat cells, and perhaps the filaria, are discovered. The fat cells are strongly refractive, and may be free or enclosed in cells or tube casts. The cells are more granular than pus cells.

Acetonuria.—Acetone is present in the urine in many serious medical disorders, especially diabetes. Of surgical diseases, it is present in malignant disease of the stomach and intestines, and in peritonitis. It is a symptom in post-chloroform poisoning, especially in children suffering from acute infective conditions.

It may occur when an excess of animal food is being taken.

Test.—Nitroprusside of potassium, and sodium hydrate to neutralize acidity, should be added to the urine, and then acetic acid, when a purple to red colour develops.

Solution of ferric chloride gives a deep red colour, disappearing on addition of sulphuric acid when *diacetic acid* is also present, as it frequently is in acetonuria, though acetone may be present without diacetic acid.

Indican is found in the urine in cases of intestinal obstruction, and in gastric and intestinal diseases associated with food decomposition.

Tests.—To urine from which albumin has been removed, add chloroform, hydrochloric acid, and a few drops of an aqueous solution of chlorinated lime, when, on shaking, the chloroform will appear at the bottom of the tube as a blue fluid if excess of indican is present.

Urinary Deposits.

1. **Organized.**—(1) **Blood-corpuscles** are present in the urine in hæmaturia, and may be detected by the microscope. They are sometimes rapidly disorganized, and should therefore be looked for early.

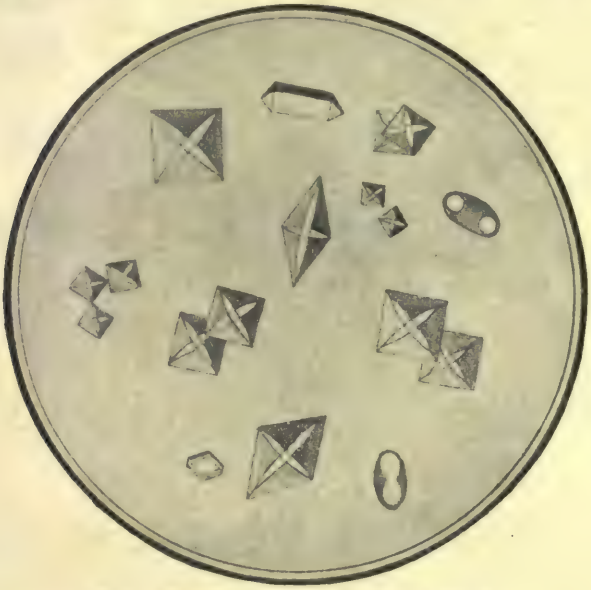

Fig. 110.—Calcium Oxalate Crystals.
(Casper.)

(2) **Epithelial cells** of various forms are found in the urine, and are recognized by the microscope. They may come from the renal tubules, pelvis of the kidney, bladder, urethra, prostate, or vagina, according to the site of the inflammation. It is not possible except in the rarest cases to tell exactly what part they do come from.

(3) **Urinary casts** of various kinds may be recognized microscopically in the urine of those suffering from disease of the urinary passages; they may be granular, epithelial, waxy, or fatty.

(4) **Sarcinæ** and various micro-organisms are at times found in the urine.

2. **Unorganized.**—(1) **Uric** or **lithic acid** (gravel) occurs in the form of "cayenne pepper" granules, dusky red in colour from absorption of urobilin.

The urine is acid and of high specific gravity. The deposit is not soluble in boiling water, but readily so in alkaline solutions. On reacidulating the uric acid is precipitated as white needle-shaped crystals.

Microscopically uric acid is seen as flat rhombic crystals, lozenge-shaped plates, or masses of acicular crystals.

(2) **Urates** of sodium and potassium occur in acid urine of high specific gravity as amorphous granules of variable colour, which are soluble on boiling.

(3) **Calcium oxalate** appears in the form of small octahedrals in the urine of dyspeptic patients, which is of low specific gravity, pale, abundant, and slightly acid. Microscopically they are seen as envelope and dumb-bell-shaped crystals.

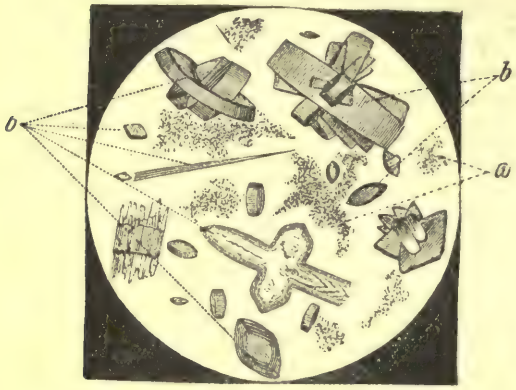

FIG. 111.—*a*, Acid sodium urate; *b*, uric acid crystals. (Casper.)

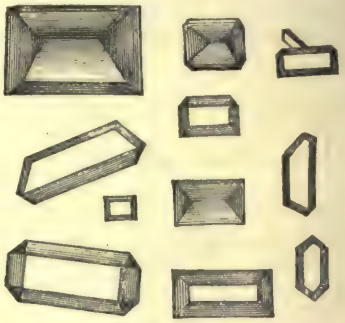

FIG. 112.—TRIPLE PHOSPHATE CRYSTALS. (Casper's "Genito-Urinary Diseases.")

(4) **Phosphates** occur in three forms :

(*a*) Triple phosphates (ammonio-magnesium), found in alkaline urine ; always vesical in origin, and are seen microscopically as "knife-rest" crystals.

(*b*) Amorphous, in chronic cystitis.

(*c*) A mixture of the two.

The deposit becomes more distinct on boiling, and disappears on adding acetic acid.

Various other bodies may be found in the urine, such as spermatozoa, prostatic threads, tube casts, etc., but they are of no great clinical importance.

Effects of Certain Drugs on the Urine.

Drug.	Colour Present.	Odour Present.	On Adding.
Phenol compounds ..	Green to brown	—	—
Tar preparation ..	Green	—	—
Uva ursi	Green	—	—
Copaiba	Red	—	HCL
Sandal-oil	Milky	—	Heat or HNO_3
Styrax	Milky	—	Heat or HNO_3
Turpentine	—	Violets	—
Iodine	Violet	—	HCL and chloroform
Bromine	Yellow	—	HCL and chloroform
Potassium chlorate ..	Blue	—	HCL, KI, and heat
Antipyrin	Red	—	—
Santonin	Bright yellow	—	—
Rhubarb	Red	—	—
Senna	Red	—	—

INJURIES TO THE BLADDER.

The bladder may be injured in various ways, and result in either contusion or rupture. The former is not likely to lead to any serious consequences. Rupture of the bladder may be produced by direct violence to the lower part of the abdomen, especially if the organ be more than half full; or by violence from below, especially by a penetrating wound from the region of the perineum. It may also be produced by the violence which causes fracture of the pelvic bones or by the penetration of a spicule of the broken bone. Should the organ be empty, it is not liable to injury apart from fracture of the neighbouring bones.

The anatomical arrangement of the peritoneum should be remembered. It covers the upper and back part of the organ, and is reflected anteriorly along the urachus, laterally along the obliterated hypogastric arteries, and posteriorly on to the rectum. It will therefore be seen that if the rupture involve the posterior or superior parts of the bladder, which are the positions in which it is usually met with, the injury will be complicated by involvement of the peritoneum. Severe shock will be experienced. Should the patient recover from this, there will be the danger of septic peritonitis to meet, which at times runs a quick and fatal course. If efficient treatment be adopted, the result may be good, but on the whole the prognosis is not very encouraging. Even if the rupture and subsequent peritonitis be recovered from, the patient may later on suffer from loss of control or want of expulsive force owing to weakening of the muscular tissue. These points must not be lost sight of in case of injury, as it is not only the immediate effects which have to be considered, but also what may be the resultant condition.

Should the rupture be extraperitoneal, the danger of peritonitis is of course avoided, and the initial shock is not so severe. The extravasated urine, however, finds its way into the cellular tissue of the pelvis, and if septic sets up acute suppuration, which often ends fatally. Even if it be not septic, it often gives rise to considerable inflammation of the part. As to prognosis, a good deal will depend upon prompt and efficient treatment and the normal health of the individual.

Symptoms.—These are quite disproportionate to the extent of the injury. There is often not much shock, and the patient may be able to walk to hospital. There is pain and tenderness over the hypogastric region, with a desire to pass water, on attempting to do which there is probably increased pain, but no urine is discharged. If a catheter be passed, no water is as a rule found, and the bladder is recognized as contracted. Occasionally the instrument may pass through the rent and draw off water from the peritoneal cavity. The test of passing a measured quantity of fluid into the bladder to see if it returns is fallacious, since the whole of the fluid may in some cases return.

Treatment.—Immediate laparotomy and careful suture with catgut of the bladder wound after cleansing the peritoneal cavity.

For extraperitoneal rupture it may be sufficient to give exit to the extravasated urine by means of incisions in the perineum, scrotum, or abdominal wall, according to the position of the rupture. As a rule, however, the bladder should be sutured.

DISEASES AND INJURIES OF THE PROSTATE GLAND.

Occasionally, and in common with other defects, **absence** of the prostate is met with.

Atrophy from pressure of neighbouring tumours, or more usually owing to slight stricture, sometimes occurs. Loss of function may result.

Acute Prostatitis — Causes. — Backward extension in gonorrhœa; stricture; chill; sexual abuse.

Symptoms.—Pain, referred to the neck of the bladder; frequent and painful micturition; painful defæcation.

On rectal examination the organ is found to be enlarged, painful, and hot.

Suppuration may follow, and be associated with retention of urine. Prostatic abscess produces very marked symptoms: there is complete prostration; rectal examination will reveal a fluctuating tumour unless the abscess is situated in the anterior part of the gland, when the feeling will be that of an indurated hard mass simulating a tumour, but to be diagnosed therefrom by the constitutional symptoms. Sometimes there is no fever, in which case the diagnosis will have to be cleared up by puncture through the rectum. The process may go on till the gland is entirely destroyed, and thus produce **sterility,** owing to the absence of the prostatic secretion to vitalize the spermatozoa (Fürbringer), or, as suggested by Casper, owing to obliteration of the lumen of the vas. If the suppuration extends into the connective tissue in front of the rectum, the symptoms increase in severity and the prognosis is bad.

Treatment.—Reduce pain and fever. Therefore confine the patient to bed, keep the bowels freely open, and give a light, nutritious diet. Locally heat should be applied to the perineum in the form of sitz baths or fomentations. This relieves the congested prostate by drawing the blood to the external parts.

To empty the bladder it is well to employ soft catheters.

It may be necessary, when the pain is very severe, to give narcotics. Antimony and hyoscyamus are useful at times.

If suppuration occurs, the abscess should be opened as a rule through the perineum, but sometimes through the rectum, if that be the shorter route to the focus of pus.

Chronic Prostatitis.—The chronic form may be caused by similar agencies to the acute, or it may occur subsequent to an acute attack.

It is the **most common cause of gleet** after gonorrhœa, since the inflammation of the urethra spreads back to the ducts of the gland, where the condition is difficult to treat.

Symptoms.—Some cases give rise to no symptoms, and exist without the knowledge of the patient. If the condition becomes worse, there is a sense of weight and fulness in the perineum, combined with irritability of the bladder. There is pain on micturition, which is referred to the end of the penis.

A white discharge or thready filaments are sometimes present in the urine, but that is not evidence of the presence of prostatorrhœa, which may or may not occur. Pus may be excreted.

PLATE LXXIII.

TUBERCULOUS DISEASE OF THE PROSTATE AND VESICULÆ SEMINALES, SHOWING EARLY STAGE OF SECONDARY TUBERCULOUS ULCERATION OF PELVES OF THE KIDNEYS.

(Museum, Queen's University of Belfast.)

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Diagnosis.—The condition has to be distinguished from tuberculous disease of the prostate which is sometimes difficult, but a careful consideration of the history, especially as regards gonorrhœa, the presence of nervous symptoms in connection with sexual life, and the absence of the tubercle bacillus, will usually clear up the case. Palpation of the gland through the rectum will reveal an **irregular** organ, which is hard here and soft there, but is not abnormally sensitive.

It should be remembered that the **normal gland is sensitive.**

Treatment.—In mild cases leave the patient alone, and induce him to leave himself alone. If there be constant excretion of pus, and bacteria are present in the urine, the bladder should be irrigated with silver nitrate solution (1 in 4,000) or perchloride of mercury (1 in 1,000), and gentle massage of the prostate employed. At the same time all possible causes of the condition, such as stricture, stone, etc., should be removed.

Tuberculous Disease of the Prostate.—This disease is usually met with in young adults, and may occur as a primary lesion in those who belong to a tuberculous stock, or it may be, and usually is, part of a tuberculous invasion which has other foci either in the lungs or in the genito-urinary tract. The tubercle bacillus finds its way to the prostate (1) through the blood-stream, (2) from the kidney, (3) from the urethra, by cohabitation with a tuberculous woman or by means of an infected catheter. It may also occur as the result of trauma and chronic gonorrhœa in predisposed subjects. Heredity has a strong influence in the production of this form of tuberculosis.

It occurs in one of two forms : (1) a cold abscess ; (2) a more or less rapidly spreading tuberculosis, in which case the bladder and kidneys are early affected.

Caseous masses at first isolated soon break down, and run together till the gland is destroyed ; and the capsule and sheath being ulcerated through, the disease spreads to the surrounding parts, and may become generally disseminated, or may burst into the rectum or bladder.

Symptoms.—There is irritability of the neck of the bladder, with pain referred to the penis or to the back, pain and fulness in the perineum. The urine contains blood, pus, threads from the gland tubules, and the tubercle bacillus.

The last few drops of semen expressed are frequently tinged with blood (hæmospermia). The reaction of the urine is neutral or faintly acid.

Rectal examination shows the prostate and vesiculæ seminales to be irregularly enlarged ; the gland is soft and hard in different spots.

Treatment.—Local treatment is contra-indicated unless the prostate be the sole focus of disease, when it may be removed. If, however, the condition is a cold tuberculous abscess, this may be opened through the perineum, scraped, and iodoform emulsion injected. In both cases active hygienic measures should be taken, and are sometimes attended with good results.

Prostatic Calculi or Concretions.—In the normal prostate there exist bodies called **corpora amylacea**, which are really formed by thickened prostatic secretions around a degenerated cell. These do no harm, but if they increase to such a size as to project above the

level of the urethra, or become coated with lime salts, they give rise to symptoms. They may thus be divided into—

(1) Prostatic concretions derived from inspissated mucus.

(2) Carbonate of lime calculi, probably having a nucleus of (1).

Symptoms.—Irritability of the neck of the bladder and interference with the flow of urine are the chief signs. The urine may be blocked altogether at one time, and free at others.

Treatment.—Wait to see if calculi are voided; if not, make a prerectal incision into the gland and remove the calculi.

New Growths of the Prostate.—These may be malignant or innocent. The former are much more common than was formerly believed, and occur usually as primary growths. Simple hypertrophy rarely if ever takes on malignant changes, the tumour is either simple or malignant from the beginning.

Malignant Tumour (Carcinoma). — This may occur as adenocarcinoma or as schirrus, the physical signs differing according to whether the soft or hard variety is present. It is usually found in elderly people.

Symptoms.—Pain **independent of micturition,** and also during the act, which is frequently performed. There is straining at the commencement and a diminished stream which has little projectile power. Retention, but not so complete as in hypertrophy, may follow. Incontinence, if it occur, is due to the growth interfering with the action of the sphincter.

There is difficulty and **pain** on defæcation. Examination *per rectum* reveals enlargement of the gland, which is irregularly **hard,** the hardness as a rule being much greater than that of hypertrophy, nor can the mucous membrane be moved over the tumour.

There is involvement of the inguinal glands, frequently continuous pain in the legs from pressure of glands on the nerves, and a progressive cachexia.

The urine may be clear or may contain blood and pus, and rarely shreds of the growth.

Sarcoma.—Most frequently met with in children; when it occurs in adults, the disease gives rise to similar symptoms to those met with in carcinoma.

In **children** the first symptom is usually a sudden retention of the urine. On examination, a tumour of considerable size will be found in the region of the prostatic pouch. The growth is usually hard, and may sometimes be felt through the anterior bladder wall. It may be that the first symptom is painful and difficult micturition, with perhaps some blood in the urine.

The prognosis is bad; the tumour quickly enlarges, and death ensues in about two years.

Treatment. — 1. *Symptomatic:* Catheterization with **soft** instruments to draw off urine; narcotics and hot applications applied to the perineum to relieve pain.

2. *Radical:* If the case is seen early, complete prostatectomy should be performed, but not otherwise.

Benign Tumours of the Prostate (Hypertrophy).—The normal prostate may be compared in size to a walnut. In elderly men there is some enlargement, which cannot be considered as entirely pathological. In many cases, however, this increases till it interferes with the normal

HYPERTROPHY OF THE PROSTATE WHICH HAS PRODUCED SERIOUS OBSTRUCTION OF THE URETHRA, LEADING TO DILATATION OF THE URETERS.

An early stage of hydronephrosis.

(Museum University of Belfast.)

[To face page 642.

evacuation of the bladder. In some it assumes such magnitude that the prostate is many times its normal size. This leads to retention of urine, more or less complete, with all its untoward results—*cystitis*, from the presence of residual urine, by which is meant the portion left behind after the most complete voluntary evacuation; *hydronephrosis*, from backward pressure; *pyelonephritis*, from ascending infection.

Diagnosis of Prostatic Tumours.—

	Carcinoma.	Sarcoma.	Hypertrophy.
Age	Advanced	Young	Elderly
Pain	Constant	Constant	On micturition
Micturition	Does not relieve pain	Relieves pain a little	Relieves pain
Retention	Gradual, late, and incomplete	Early and sudden	Late and complete
Tumour	Densely hard	Hard	Firm
Cachexia	Progressive	—	Intermittent
Growth	Usually fairly rapid	Rapid	Slow

The enlargement may be due to increase in the size and amount of—

1. The gland tissue = **adenoma.**
2. The muscular and fibrous tissue = **fibro-myomata.**

Of the latter there are two forms:

(1) Diffuse fibro-myoma, or general enlargement.

(2) Nodular fibro-myoma, which exists as isolated firm tumours set in the midst of normal gland tissue.

Observers differ as to the relative frequency of these varieties. On the whole, it is probable that the adenomatous changes are the most common.

Symptoms.—Frequency of micturition, which is worst at night; difficulty in beginning to pass water, which, when it comes, is not projected in the normal curve, but falls straight down as it issues from the urethra; on straining to propel the stream farther it may stop altogether; the flow may be intermittent, and there is usually dribbling at the end of the act; pain and weight in the perineum is usually complained of.

Marked pain and hæmaturia are later symptoms.

By the enlargement of the organ a post-prostatic pouch is formed, which cannot be emptied by natural means. This pouch gradually increases in size, and the bladder walls become weakened and distended, till in old unrelieved cases there may come a time when overflow incontinence takes place.

Diagnosis.—In a patient with the foregoing symptoms, the rectum should be carefully examined to ascertain the condition of the prostate as to size, regularity, tenderness, and hardness, remembering that there may be considerable enlargement in a forward direction without the gland appearing to be enlarged *per rectum*.

A catheter, either a soft rubber instrument or a coudée, should be passed, and the place and amount of resistance noted. The patient having previously passed water, the amount of urine now drawn off will indicate the size of the prostatic pouch and the necessity for certain lines of treatment.

Treatment.—When the symptoms are very slight, nothing beyond hygienic treatment is necessary.

If there is obstruction, but no residual urine, Freyer recommends the passing of a large-sized steel director once a week, and leaving it in position for ten minutes with a view to causing absorption. At the same time the liquid extract of ergot is administered.

If the residual urine exceeds **two ounces, catheter life** should be entered upon. At first it will only be necessary to pass an instrument once in forty-eight hours, but as the amount of residual urine increases the frequency of instrumentation must also be increased. The patient should at the same time be instructed to pass water every four hours. When the power of voluntary urination is lost, the patient should be carefully instructed in the art of passing the catheter, and use it as frequently as the call to urinate is made. Operative procedure should be undertaken (1) when there is complete retention in an old-standing case, (2) when there is great and increasing difficulty in passing a catheter, (3) when cystitis and other septic conditions have been set up, or (4) when the constant desire to micturate produces worry and leads to prostatic cachexia.

Complete Enucleation of the Prostate.—The outlook on operative procedure in these cases has been much altered since Freyer introduced his operation. This consists of a complete removal by the suprapubic route of the prostate **in** its capsule **from** its sheath. These terms caused needless apparent confusion in the minds of some. The prostate originally consists of two organs, each surrounded by a thin but strong fibrous capsule. At an early period of fœtal life they are joined together, and embrace the prostatic urethra, the whole organ becoming apparently one enclosed in a capsule, which is, however, somewhat deficient where the line of union has taken place above and below the prostate, at which points during the operation it can as a rule be divided and the gland shelled out in two, leaving the urethra intact. If this cannot be done, the organ is removed as a whole with the prostatic urethra.

The prostate and its capsule is enclosed in its sheath, derived from the pelvic fascia, which is not, of course, removed in the operation.

The whole arrangement might be aptly illustrated by an orange with its closely-fitting white capsule embedded in its rind or sheath.

Between these two layers lie the prostatic plexus of veins, often very much enlarged in the subjects of prostatic hypertrophy. It is hard to imagine any condition of things in general enlargement of the prostate when Freyer's operation would not be the procedure of election, but various other methods have been adopted, some of which are now historical curios.

Perineal Prostatectomy.—The perineal route is still preferred by some, who consider it the most direct, and that drainage, if required, is better secured. The operation has been variously performed and modified by Dittel, Nicholl, Freyer, and others.

Suprapubic Prostatectomy.—This, principally performed by McGill, is not a total extirpation, but the removal of a portion of the gland, and is suitable in cases where there is enlargement of the so-called "middle lobe," or a tumour of the lateral lobes as distinct from a general enlargement.

Bottini's Operation.—This consists of the division of the obstruction by means of a galvano-cautery passing through the urethra. The operation has been modified by Wishart and Watson, who passed

the cautery through an opening in the perineum made at the apex of the prostate.

Perineal Puncture.—This consists in the removal of the obstruction through a perineal opening by means of specially-constructed forceps.

Castration.—This operation was undertaken because of the resultant shrinkage in the size of the prostate, but is contra-indicated on account of the mortality, mental disturbances, and for sentimental reasons.

Vasectomy (division and excision of a portion of the vas deferens).—This operation was undertaken with a view to obtaining similar results to those following castration. The shrinkage of the prostate, however, is not so great nor so immediate, and permanent good results are not the rule.

Drainage.—This may be carried out as a palliative measure in advanced cases, or occasionally as a preliminary to operation. When temporary, and no operative procedure is contemplated, the perineal route should be chosen, otherwise the suprapubic one.

INJURIES OF THE PROSTATE.

The organ may be injured by violence applied to the perineum, though it is not usual that it alone is injured, but rather it takes part in a more extensive accident. The condition produced may be one of contusion or rupture; if the latter, and the prostatic plexus be injured and the urethra opened, severe hæmorrhage may be expected. In all cases of injury to the prostate there is danger of septic infection and of the formation of periprostatic abscess.

AFFECTIONS OF THE URETHRA AND PENIS.

CONGENITAL MALFORMATIONS.

Hypospadias (an abnormal opening on the inferior wall of the urethra owing to defective development).—It may be incomplete or complete, according to whether it is limited to the gland or penis, or extends into the perineum. In the latter form hermaphroditism is closely simulated.

Treatment.—Operative procedure is unnecessary where the malformation is limited to the glans penis; in other cases it is best to postpone it till puberty, unless in cases where the symptoms of interference with urination demand instant attention. The operation consists in making an artificial meatus, and in freshening and drawing together the divided floor to form a urethra in connection with the new opening.

Epispadias.—In this condition the urethra is partly or wholly exposed along its upper border. According to Morris, it is not, properly speaking, a division or deficiency of the upper wall, but of the lower, which has been transposed to the top by torsion of the penis—"hypospadias upside down."

Treatment.—This consists in rectifying the curvature of the penis and closing the urethra by a plastic operation, flaps being taken from the abdomen or penis.

Imperforate Urethra.—This may be complete or incomplete. In the latter the constriction is met with at or near the meatus as a rule. Where the condition has existed during a considerable part of fœtal life, and there is no abnormal opening for the urine to pass, the condition will be associated with **congenital hydronephrosis.**

Treatment.—Consists of breaking down the obstruction, or, where this is caused by a long fibrous cord, of making a new passage and closing any abnormal one that may exist.

Absence of the Urethra, Dilatation, Abnormal Opening, and **Double Urethra** (associated with double penis), are congenital conditions seldom met with.

ACQUIRED CONDITIONS.

Stricture of the Urethra.—Sir Charles Bell has described stricture as a condition in which the affected part of the urethra has lost its dilatability. This definition excludes spasmodic and congestive strictures, but includes organic, which is the only true stricture. The former conditions may, however, be superadded to the latter, so as to produce a mixed variety. Thus, a man may be suffering from a slight organic stricture, interfering to some extent with the passage of water, and may discover some day, or night, that he is unable to pass any water. How far this is due to permanent and how far to temporary stricture must then be determined.

Spasmodic Stricture.—This is due to spasm of the muscular tissue in the urethral walls, and is caused by operative procedure on or about the genito-urinary organs or the rectum; by venereal excess, or exposure to cold, especially after a drinking bout, in those suffering from partial true stricture.

There may be complete retention, or merely a diminution in the stream. If an instrument be passed, the spasmodic contraction is detected as a quite different form of obstruction to the hard organic stricture. Freyer points out that the spasm is usually in the deep urethra, and is often accompanied by true stricture of the anterior part of the canal.

Temporary retention is the rule. This is nearly always relieved by giving an enema and placing the patient in a hot bath. A hypodermic injection of morphia should be administered at the same time. If these means fail, a large soft catheter should be carefully passed. At times a general anæsthetic has to be administered to relieve the spasm.

Congestive Stricture.—This is a temporary diminution in the size of the urethra caused by an inflammatory swelling which partially or entirely occludes the canal. It is generally due to specific or traumatic urethritis, or it may be produced by inflammation of the prostate. The treatment is the same as for spasmodic stricture, with which the congestive type may be combined.

Organic Stricture.—This is produced by the development of fibrous tissue within the walls of the urethra.

STRICTURE OF THE URETHRA, ANTERIOR TO THE BULBOUS PORTION, WITH A SECOND STRICTURE IN THE MEMBRANOUS PART, AND A FISTULA-IN-PERINEO BETWEEN THEM.

The bladder is thickened and its mucous membrane inflamed and studded with patches of adherent lymph.

(Museum, University of Belfast.)

Causes.—1. Gonorrhœa, especially repeated attacks followed by long-continued gleet.

2. The deposit of cicatricial tissue following urethral chancre, chancroid, ulcer, or abscess. Casper denies the existence of syphilitic stricture.

3. Traumatism which has caused rupture of the urethra, as after a fall astride a fence or a kick in the perineum ; a tear during instrumentation or coitus ; an abrasion by the passage of a stone ; cauterization by injection of corrosive fluids.

As the result of gleet the bulbous portion is that usually affected, though the penile may be affected alone or in conjunction with a stricture in the deeper portion of the urethra.

As the result of healing chancre the stricture is near the meatus.

Situation.—Traumatic : bulbo-membranous junction or in the membranous portion, this part being caught between the source of the external trauma and the pubic arch. Where the trauma is internal, the injury may be situated anywhere.

Type.—Strictures may be divided according to their **physical conditions** into—

1. Annular, where the whole lumen is involved.
2. Bridled, where only a portion of the circumference is affected.
3. Ribbon-shaped, where a broad surface of the entire lumen is involved.
4. Tortuous, where the passage is irregularly involved, being broad at one part and narrow at another.

Strictures are divided **clinically** into—

1. Simple, when the stricture is easily dilatable.
2. Resilient, when there is a tendency to recontract.
3. Indurated, when the scar tissue is very dense.
4. Irritable, when there is pain and bleeding on instrumentation.
5. Impassable, when no instrument can be passed.
6. Impermeable, when no urine can pass. This form is practically non-existent as an organic stricture.

Symptoms.—In many early cases there are practically no symptoms that are noted until some secondary occurrence leads to more careful notice being taken of the part.

The stream is smaller; therefore the time taken to urinate is longer.

The water is divided or twisted. This last symptom may be present with a normal urethra.

The act of urination is difficult, perhaps painful.

Dribbling after the act from atony of the bladder or inefficiency of the urethral muscles concerned.

Increased frequency of micturition, due to reflex irritation of the neck of the bladder, or to cystitis from decomposition of retained urine, or to inability of the patient to empty the bladder.

Sudden complete retention.

Pathology—*Urethra anterior to Stricture.*—Normal.

Urethra at Stricture.—Wholly or partly replaced by a greyish-white fibrous cord, which is a development of cicatricial tissue immediately beneath the mucous membrane and intimately adherent to it. It extends for a variable distance, and is associated with some peri-urethral infiltration.

Urethra behind the Stricture.—Dilated, the mucous membrane is velvety and friable; the orifice of the lacunæ and other glands are

dilated; by lymphatic absorption or escape of urine a peri-urethral or perineal abscess may be set up, leading later on to perineal fistula.

In old cases of tight stricture the pouch behind the stricture may give way, leading to perineal abscess or extravasation of urine into scrotum and perineum.

The *Bladder* becomes involved in old-standing cases, which produce hypertrophy and sacculation. The saccules may harbour calculi or stagnant urine. Later on distension replaces hypertrophy, and the bladder will become thinned and atonic.

The *Kidneys* take part in the backward pathological process. Pressure may set up hydronephrosis, and extension of sepsis lead to pyonephrosis and pyelonephritis.

Diagnosis.—The diagnosis of organic stricture is not very difficult if attention be paid to symptoms. Mistakes as to the kind of stricture present should be avoided by the history, and the relief of symptoms by the simple means already referred to. The diagnosis of a stricture can only be quite certainly made by attempting to pass an instrument, but much useful information with regard to it can be obtained by the use of the urethroscope, which should not be neglected.

Catheters and their Use.—Of the making of catheters there is no end, and their nomenclature is as diverse. For the appearance and names of all these various forms the student must turn to the voluminous guidebooks of the instrument-makers.

Catheters may be hard, soft, or flexible. The hard or metal catheters are made of silver, they are easily kept sterile, and are preferred by some surgeons to all others. They should be well made, having a proper curve and a good smooth eye.

The flexible catheters are the English gum-elastic, silk-web coated with shellac, and the French black olivary.

The soft are made of rubber, and are usually straight and rounded at the point.

A modification of the flexible catheter is the coudée and bicoudée, for use with an enlarged prostate; they are made long on account of the increased length of the urethra.

Bougies.—These are solid, and are made in the same patterns and materials as catheters.

The curved olivary metal bougie (Lister's), which ranges three numbers from point to shaft, is a good instrument for diagnosis and treatment.

The small gum-elastic corkscrew bougie is useful for finding its way through an irregular stricture. Filiform bougies made of thin whalebone are of use as guides, as they pass through a very small aperture, and curl up in the bladder out of the way of the larger instrument to which they are attached.

A No. 8 soft rubber catheter with a good bevelled oval eyelet situated a little above the end, which should be blocked so that no septic matter can accumulate, is the instrument to depend on at all first examinations of the urethra.

The olivary-shaped catheters and bougies are very serviceable, and find their way through a stricture when an ordinary blunt-pointed instrument will not do so.

Some surgeons prefer bougies to catheters, but it is a great satisfaction, after negotiating a difficult stricture, to see the water coming away, and be thus sure you have reached the bladder. This is, of course, impossible when a bougie is used.

To sterilize catheters, the metal and rubber ones should be boiled, and other varieties placed in boiling water and afterwards in strong boracic or weak carbolic lotions, as boiling destroys their surface.

To **pass a catheter or bougie,** the patient should be placed on his back, while the surgeon as a rule stands on his right side. The instrument, previously sterilized, warmed, and anointed with sterilized oil, vaseline, or glycerine, should then be inserted gently, giving little or no pain, and drawing no blood if at all avoidable. In the normal urethra the instrument will slide easily into the bladder, except for a slight hindrance as the membranous portion is reached, owing to narrowing of the tube and pressure by the compressor urethræ muscle. Where a stricture exists, an obstruction will be felt when the point of the instrument reaches its situation. If after steady pressure for a moment or two the instrument does not move forward, it should be withdrawn and a smaller one tried. If this, again, will not pass, a still smaller one is used, and so on till a size is reached which will pass. It may be that, if no straight instrument will pass, a twisted one (No. 0 or No. 1) will do so. It should be used with a slightly corkscrew motion. If that also will not pass, the stricture may be deemed impassable.

When a curved metal instrument is used, the handle should be held over the patient's left thigh till the point reaches the perineum, when the handle is brought round to the middle line and raised to the vertical position, and then gently depressed between the patient's thighs. The instrument, when no tight stricture exists, finds its way without **pushing** into the bladder.

The three points of difficulty in passing a catheter are—

1. At the meatus, which may have to be incised.
2. At the situation of the *lacuna magna*, which is best avoided by keeping the point of the instrument against the floor.
3. At the opening in the triangular ligament, where the point of the instrument should be passed along the roof.

Dangers of Catheterization—1. **Shock.**—This is best prevented by passing about half a drachm of a 5 per cent. solution of cocaine, followed in a moment or two by a drachm of warm sterilized olive-oil. If the instrument be now inserted quickly, it slips in on the oil almost without the patient feeling it.

2. **Hæmorrhage.**—From laceration of the mucous membrane or by the formation of false passages. It is rarely excessive, but if it is adrenalin solution may be injected or a hard catheter tied in.

3. **False Passages.**—These are, unfortunately, not uncommon in connection with stricture, through careless manipulation and lack of gentleness in using instruments. It is impossible to trace the vagaries of false passages; they seem to the exasperated surgeon who is trying to reach the bladder to run in every direction but the required one. Frequently the instrument pierces the mucous membrane of the floor, and re-enters the post-strictural pouch behind the stricture, or it may even enter the bladder by passing under the prostate.

Symptoms of False Passage.—Sudden pain and hæmorrhage, with a quick onward movement of the instrument, which becomes slightly deflected from the middle line. On rectal examination the point of the instrument can be felt in an abnormal position, sometimes in the rectum itself. False passages are not dangerous unless they are extensive, when they may lead to peri-urethral inflammation, and even extravasation, but they complicate future treatment.

4. **Inflammation.**—Trouble may be lighted up in the prostate, and epididymitis induced by extension along the vas deferens. These conditions are usually due to sepsis.

5. **Urinary Fever.**—This is usually septic in origin, and, though occurring as a solitary rigor in normal individuals, is more common in those with damaged kidneys. It should be distinguished, in those who have been resident abroad, from malaria, an attack of which it somewhat resembles.

6. **Anuria.**—This condition may result in cases where the kidneys are diseased. They should be cupped, the bowels cleared out, and a hot-air bath taken, while at the same time a hypodermic injection of pilocarpine is given.

7. **Uræmia.**—This condition may be produced. Copious repeated intravenous injections of normal saline solution will give relief.

As a routine treatment after catheterization, 5 grains of quinine should be administered to obviate trouble that may arise through a slight abrasion of the mucous membrane.

Treatment of Stricture.—As Freyer points out, the various ways of treating stricture should not be looked upon as rivals, but rather as complementary to one another.

The method of treatment will depend on whether the stricture is **passable** or not. It has been laid down that any stricture through which urine can pass is capable of being negotiated by a catheter. While there is no doubt that, in skilful hands and under a proper régime, few strictures exist through which an instrument cannot be passed, to say that none such exist is incorrect. It is well, however, not to conclude too quickly that a stricture is impassable. There is no domain of surgery in which, "If at first you don't succeed, try, try, try again," should be more clearly remembered, always bearing in mind that your patient should not have too long a sitting at one time. If, then, a stricture seems to be impassable, three methods of procedure are open to us :

1. Confine the patient to bed for a day or two, and put him on light diet and demulcent drinks, after having the bowels well cleared out when it will often be found that a catheter can be passed.

2. Engage the point of a catheter in the stricture, and leave it in position for a few hours, when it may pass through to the bladder.

3. Bring the orifice of the stricture into view by means of the urethroscope; a fine instrument is then introduced, and held in the mouth of the stricture while the urethroscope is withdrawn. This is especially useful when false passages exist.

Failing still to pass an instrument, the stricture may fairly be held to be impassable.

Bearing these points in view, we may divide treatment into that for—

I. **Passable Stricture**—1. **Dilatation.**—This is the treatment that should always be adopted when possible, since after a cutting operation dilatation is still required.

Dilatation may be—

(*a*) *Gradual.*—This is the best method when rapid cure is not an object and where the patient is anxious to continue at his occupation. It is carried out by first finding a catheter or bougie which will pass through the stricture easily, then passing one of higher size, say No. 2 E. The patient is directed to return on the third day, when we begin with No. 1, and pass on to Nos. 2 and 3, and so on each third

day, always beginning at a lower number than we left off at the previous sitting. This is continued till No. 16 passes easily, when the cure is complete except for passing No. 16 once every few weeks for a month or two.

The instrument used should be a fairly stiff bulbous or olivary one, which it is not always necessary to change for a steel one when the higher numbers are reached, though some surgeons do so. It is sometimes stated that gradual dilatation is not suitable for old-standing fibrous strictures, but the method is often successful in such cases.

(*b*) *Rapid.*—This is a bad method. It is carried out by passing a number of silver instruments at one sitting, and is closely allied to—

(*c*) *Forcible* dilatation, in which the stricture is torn or *avulsed.* The result is frequently a worse stricture than originally existed.

(*d*) *Continuous.*—This form is useful as a preliminary to gradual dilatation where great difficulty is experienced in passing an instrument, or to internal urethrotomy, and when a rapid cure without operation is desired. The continuous presence of the instrument is against the method. It is carried out by tying in a small, fairly soft catheter, which passes easily, and leaving it in position for twenty-four hours, when it is replaced by a larger instrument, and so on.

Rationale of Dilatation.—Force should not be used, since, while there is a gentle gradual expansion of the scar tissue, the really beneficial process is the **absorption** of such tissue, which is best affected by simple contact of the instrument. How the process takes place is not definitely known; probably it is by circulatory changes brought about by the foreign body—*i.e.*, the catheter—which produces alteration of nutrition.

2. **Operative Treatment.**—(*a*) *Internal Urethrotomy,* or division of the stricture by means of a cutting instrument introduced into the urethra.

This treatment is better than dilatation in—

(*a*) Very old dense cartilaginous strictures.
(*b*) Resilient strictures.
(*c*) Excessively irritable urethra.

It is usual to restrict its use to cases in which the stricture is in the anterior two-thirds of the urethra.

There are many forms of urethrotomes, of which two only need be mentioned: **Ceviale's**, for cutting from behind forwards; and **Tevan's** modification of Maisonneuve's instrument, for cutting from before backwards.

(i.) *From behind forwards:* This is the preferable operation. It is surer, safer, and less likely to be followed by bleeding, as the cut is made on the floor of the urethra, which is less vascular than the roof; but it can only be performed when the stricture will admit a No. 5 catheter, or has been continuously dilated up to that size. A Ceviale's instrument is inserted past the stricture, and the concealed knife is pushed out from the bulb head by means of a connection in the handle, and drawn forwards.

(ii.) *From before backwards:* This method can be used with a very much tighter stricture than the other. It has been rendered much safer since the use of guiding filiform bougies has been introduced. The roof is cut, which has the disadvantage of being more vascular than the floor. It is the preferable procedure when the deeper part of the urethra is involved, as the bulb is avoided.

When the guiding bougie of a Tevan's instrument has passed into the bladder, and the sheath is arrested by the stricture, the triangular blade is pushed forwards through the stricture, and allowed to return to cover by means of a spring button in the handle.

The patient should be kept in bed for ten days while the wound is healing, and there is no need to pass an instrument during that time. At the end of the period it will usually be found that a large-size instrument can be passed with more or less ease.

Other instruments sometimes used are—Otis's, Heron-Watson's, Berkeley Hill's—for cutting from behind forwards; and Harrison's and Berkeley Hill's for cutting from before backwards.

(*b*) *External Urethrotomy* is now an almost obsolete operation for the relief of a passable stricture, the internal operation having replaced it whenever dilatation is contra-indicated. **Syme's** operation was the procedure formerly adopted, and still sometimes performed, for a stricture situated in the posterior third of the urethra and accompanied by perineal fistulæ. The operation consists of passing a posteriorly grooved staff with a shoulder which impinges on the stricture; the groove is cut down upon, and the stricture, which must admit a No. 3 catheter, is divided from behind forward. A full-sized soft catheter is then tied in for some days, and the external wound packed and allowed to heal by granulation.

(*c*) *Excision* is occasionally performed for the relief of hard cartilaginous stricture, the urethra being subsequently joined together.

II. **Impassable Stricture.**—The treatment here will vary according to whether there be retention of urine or not.

1. **When there is no Retention.**—As already pointed out, the impassability may be only apparent and due to spasm, which will pass off with suitable treatment.

If not, **external urethrotomy** should be performed.

Wheelhouse's Operation is indicated—

(*a*) In impassable stricture.

(*b*) Where urinary fistulæ exist.

(*c*) In very tight strictures accompanied by chronic cystitis with purulent urine.

The operation consists of passing down to the stricture a Wheelhouse staff; this is grooved posteriorly to within a quarter of an inch of the end, and has a button on the anterior side. The urethra is incised on the groove of the instrument, which is then turned round so as to hook up the anterior end of the incision on the button. The edges of the wound are held apart, and the orifice of the stricture sought for. If found, a probe-pointed director is passed, and the stricture incised from before backwards. A catheter is then passed into the bladder, and the edges of the wound partially closed over it. Often the orifice of the stricture is very difficult to find, and the surgeon has to "worry" his way into the bladder. If it cannot be found, a suprapubic opening should be made.

2. **When there is Retention.**—If seen early, the patient should be placed in a warm bath, and an enema given, followed by a morphia suppository. If no urine passes, it should be drawn off by suprapubic puncture, when, owing to relief of pressure behind the stricture, an instrument can sometimes be passed. If not, an opening should be made in the perineum behind the stricture, and the bladder drained. The stricture can then be dealt with by dividing it at the same sitting,

or later on treating it by internal urethrotomy or dilatation. The latter is the better procedure where there are multiple strictures, as by the relief of pressure and by the absence of foul urine the stricture usually becomes absorbed to a considerable extent. If the stricture is a single tight one deeply situated, it had better be dealt with at once.

Perineal Section (Cock's operation).—This is practically what has just been described, and is seldom performed as an operation of choice, but rather when the orifice of the stricture cannot be found during a Wheelhouse operation, or for continued retention when no instrument can be passed.

A median perineal incision is made, with a finger in the rectum, to ascertain the position of the membranous urethra. After dividing the cutaneous structures down to the urethra, the knife is carried forwards towards the prostate strictly in the middle line. When the urethra is opened the urine flows out. It is not as a rule an easy operation. The stricture is treated as mentioned above.

Complications of Stricture—1. **Perineal Abscess.**—This has to be diagnosed from superficial abscess, lacunar abscess, and cowperitis the result of gonorrhœa, and from traumatic or ischio-rectal abscess. The abscess due to stricture is the result of extravasation of urine through a very small opening, or to ulceration of the wall of the pouch behind an old stricture.

2. **Perineal Fistulæ.**—These usually result from peri-urethral suppuration. They demand as a rule an external urethrotomy for their cure.

3. **Extravasation.**—This usually results from a giving way of the urethral wall behind the stricture. There is first a sharp pain, followed by a sense of relief. It may result from the bursting of a peri-urethral abscess into the urethra, in which case the symptoms are more gradual. The membranous portion of the urethra is the usual site for extravasation.

The urine often finds its way through a rupture of the anterior layer of the triangular ligament, its passage backward being prevented by the posterior layer, it makes its way to the perineum, scrotum, and penis. If more extensive, it travels along the spermatic cords to the anterior abdominal wall, but not into the thigh, on account of the attachment of the deep layer of the superficial abdominal fascia to the fascia lata below Poupart's ligament. If the posterior layer of the triangular ligament should be ruptured, the urine may enter the peritoneal cavity.

The effects are always serious, as the urine in stricture is often septic and tends to produce gangrenous cellulitis.

The **Treatment** is to make multiple incisions, to perform external urethrotomy, and apply copious hot boric acid fomentations.

Simple Urethritis.—A non-specific inflammation of the urethra may occur in the male as the result of the passage of instruments or calculi; in gouty subjects owing to the constant passage of highly acid urine; occasionally as a reflex condition owing to piles, fissure of the anus or urinary calculi.

Symptoms.—The discharge is thin, distinguishing it from that of gonorrhœa, and a microscopic examination will reveal no gonococcus. There is little pain and an absence of itching, while the condition heals up quickly and finally.

Treatment.—Carefully regulated diet; saline purge. Alkalines should be given first, and later on iron and the mineral acids.

Folliculitis and Cowperitis.—The follicles of the urethra are sometimes the seat of inflammation, usually of a specific nature, which causes them to feel like small shotty nodules in the wall of the urethra. Inflammation of Cowper's glands also occurs in gonorrhœa, but may be caused by traumatism. There is pain in the bulbar region and tenderness to touch. There is usually some slight swelling. If there be suppuration an early incision should be made.

Foreign Bodies in the Urethra.—These are usually introduced from without by the patient for an illegitimate purpose, or by the surgeon for a legitimate one. The substances found vary from a hairpin to the small twig of a tree. If the object be round, it is usually expelled by passing water; otherwise surgical aid must be sought, and considerable difficulty may be experienced in withdrawing the object. Frequently an opening has to be made on the under-surface of the urethra, and the foreign body manipulated through it.

Foreign bodies from within consist for the most part of calculi formed locally or passed from the bladder. They sometimes attain considerable size, and have to be removed by cutting down upon them. This is a safer procedure than trying to push or pull a rough stone which resists mild traction with urethral forceps.

New Growths of the Urethra.—These are uncommon.

Papilloma.—This is the most frequent form of tumour met with. It is usually a multiple polypoid growth situated at the internal meatus, though sometimes met with farther back. The condition is due to specific causation or to the irritation accompanying balanitis.

Symptoms.—Slight urethral discharge, occasional hæmorrhage, and symptoms of stricture if the growth be far back.

Treatment.—The anterior growths should be cut off with scissors, those farther back curetted through a urethroscope.

Carcinoma.—This is usually secondary, due to spreading from the prostate or rectum. Occasionally a primary growth is met with, when a stricture is almost invariably present, and may be concerned in the production of the condition.

Symptoms.—The early ones are usually attributed to stricture; later on a tumour can be felt, micturition becomes very painful, and there is enlargement of the inguinal glands. At this stage little can be hoped for from treatment, which consists of resection of the urethra in a posterior growth, and amputation of the penis for one situated anteriorly. If recognized early and when primary, a cure may be effected.

Cysts are occasionally met with, and are probably retention cysts associated with the glands of the penis.

Tuberculous Growths are very uncommon, and always secondary.

INJURIES TO THE URETHRA.

Puncture or laceration of the urethra occurs from a kick on the perineum or a fall astride some sharp object. It has been known to result from severe jolting, and in fracture of the pelvis is brought about by the penetration of a portion of the broken bone. The entire

urethra may be torn across, in which case urination is very difficult or impossible. Involvement of the urethra often takes place as part of a very much more serious injury.

In a case seen some years ago, an injury was brought about by the tipping up of a heavy load of clay over a carter, who thereby sustained a severe crush of the abdomen, with fracture of the pelvic bones and entire rupture of the urethra. The man suffered great agony, especially if he tried to urinate. This was forbidden, and all urine was drawn off suprapubicly. The patient did well under treatment for a time, but eventually died from septic poisoning.

Tearing or partial tearing of the urethra often leads to adverse remote results. Stricture is very often developed, which may lead to cystitis, and should the individual be in poor health involvement of the kidneys may occur as a further result, and come about at a period long posterior to the accident. Such contingencies must always be kept in mind, since, although the patient recover from the immediate effects of the accident, such a train of circumstances as that stated above may be regarded as connecting links between the injury and the fatal result.

Surgical trauma may be inflicted by the passage of an instrument through the walls, forming a false passage.

Symptoms.—In all cases there is pain, hæmorrhage, and disturbance of micturition, the severity of the symptoms varying with the extent of the injury.

Treatment will depend on whether the injury is merely in the corpora cavernosa, has ruptured the mucous membrane, or involves the entire urethral walls.

In the first case, rest and lead and opium lotion are all that is required. In the second, the urine should be drawn off by a catheter passed at regular intervals **along the roof**, as the injury is usually on the floor. In the third condition, the urine should be drawn off by the suprapubic route, the tissues incised to let out extravasated urine, and external urethrotomy performed to find and join the ends of the urethra.

The diagnosis and treatment of abnormal conditions of the urethra in front of the bulb have been made much easier since the introduction of the urethroscope, by means of which the pathological appearances can be studied and curative agents applied at the particular spot required. The light required for this may be reflected from outside, or be supplied from an electric lamp inside the tube. Experience is required to become expert in recognizing some of the conditions. Erosions and granular patches, for example, are difficult to see; while folliculitis, a soft stricture, or a polypus, may be made out with comparative ease.

A variety of instruments have been designed; the essential features of all are an external tube attached to a handle and containing an obturator. The tube is passed as far as the bulb, the obturator withdrawn, and the mucous membrane wiped. The light is then applied, and the eye placed to the orifice of the tube, when a good view of the urethra is obtained on slowly withdrawing the tube. Some allowance must be made for the condition produced by the forcible separation of the walls. To some instruments a bellows arrangement is attached, which can dilate the urethra in front of the tube. The best instrument probably is the Wyndham-Powell aero-operating urethroscope.

AFFECTIONS OF THE PENIS.

New Growths.—**Condylomata** and **malignant disease** occurring as squamous-celled **epithelioma** are the most common. The former, when small, are easily recognized as fine papillary growths, but large cauliflower excrescences may cover the whole of the glans, and be easily mistaken for a malignant growth. If, on removal of part of the tumour, the skin is found more or less normal and not penetrated by the growth, it may be deemed non-malignant; but it is advisable to have a microscopic examination made before deciding on treatment.

When the growth is malignant the skin is perforated, and the growth, which usually begins in the sulcus behind the corona, extends into the underlying tissues, sometimes penetrating as far as the urethra.

Treatment.—Condylomata should be cut or scraped away and the base treated with resorcin (5 per cent.).

Malignant growths should be widely removed by amputating the penis through healthy tissue. If seen early the prognosis is good; otherwise the growth will return in the glands of the groin and pelvis.

Lipoma, Fibroma, and **Sarcoma**, are occasionally met with. When present, the two former tumours should be removed by as conservative a method as possible. The latter, if seen early, by removal of the penis.

Balanitis.—This is an inflammatory condition of the mucous membrane covering the glans, due to sepsis arising either from specific disease or uncleanliness.

Symptoms.—Heat, pain, and sense of weight, with disagreeable odour and swelling of the skin around the glans. The surface of the glans, when it can be seen, is red and abraded, and is easily made to bleed. The inflammation may be so acute as to set up congestive phimosis or paraphimosis, which, if not relieved, may be the cause of gangrene. Occasionally preputial calculi composed of smegma and urinary salts are formed, causing great pain.

Treatment.—The foreskin should be drawn back and the penis freely bathed with an antiseptic wash, such as 1 in 5,000 perchloride of mercury. A small piece of cotton-wool should be wrung out of the lotion and worn between the foreskin and the glans.

Phimosis.—In this condition the skin of the prepuce is so narrow that it cannot be pulled back over the glans. There are varying degrees of the condition, from the pin-point opening in front of the glans to those cases where the skin can be partially retracted. Frequently a previously normal foreskin becomes narrowed by the development of venereal disease and simple or malignant inflammation.

The condition is an obvious one, but in many congenital cases the skin with care can be drawn back and operation obviated, and in some the condition is recovered from spontaneously.

Treatment.—In simple cases of complete phimosis, congenital or otherwise, circumcision should be performed.

When arising from inflammatory causes, bathing in lead and opium lotion and rest should first be tried. Failing in this line of treatment, a partial circumcision should be performed by dividing the skin and mucous membrane on the dorsum; the affected part can then be

reached and treated, and the operation completed at a later date when inflammation has subsided.

Paraphimosis.—This is a reverse condition to phimosis, but often results from a partial phimosis in which the tight foreskin has been drawn back. The prepuce is fixed behind the glans penis, and cannot be drawn forwards. Œdema of the glans and of the prepuce sometimes occurs, rendering the drawing forwards of the foreskin wellnigh impossible, and gangrene of the part results.

Treatment.—The ends of both thumbs should be placed on the head of the glans, while the œdematous band is pressed between the first and second fingers of each hand, which at the same time draw forward the foreskin while steady pressure is exerted backwards on the glans by means of the thumbs.

Failing reduction, the constricting band should be divided on the dorsum in one or two places, and the glans replaced, or, if this fail, the whole thickness of the skin of the penis may be divided. In some cases it is sufficient to incise the œdematous tissue, when reduction can be effected. Lead and opium lotion may then be applied to the organ, previously dusting the wounds with traumatol or iodoform.

Elephantiasis.—This condition occasionally occurs in this country following stricture, traumatism, or gonorrhœa. Beginning at the prepuce, the disease invades the skin of the penis. The organ itself frequently escapes.

Treatment.—Removal of the tumour after passing a tourniquet round the root of the penis. If the tumour is operated on from the dorsal aspect and the penis carefully approached, it may be found that much of the organ can be saved.

Lymphangitis and Lymphadenitis.—These are sequelæ of specific and septic infections, and occasionally of traumatism. It is unusual for the infection to manifest itself until it reaches the glands of the groin, into which the lymphatics of the penis empty, but occasionally thread-like, hard, nodulated cords can be felt on the dorsum of the penis.

The **Treatment** in such cases is rest and elevation of the penis, with the application of lead and opium lotion alternating with mercurial ointment.

Infections of the Penis leading to Secondary Enlargement of the Glands.—The inguinal glands become enlarged in different ways according to the nature of the infection. When syphilitic they are hard, separate, and movable, and do not tend to suppurate; when gonorrhœal or septic they usually become attached to the surrounding tissues, and suppuration is frequent.

Treatment.—Antispecific and antiphlogistic. When suppuration occurs, the abscess should be opened parallel to Poupart's ligament, and the pus carefully evacuated from the cavity, including possible "pockets." The cavity should be scraped and irrigated with hydrogen peroxide; iodoform emulsion (10 per cent.) should then be injected, and a spica bandage applied.

Herpes occurs on prepuce and glans. It may result from simple local irritation in a gouty subject, but is more frequently seen in those who have suffered from syphilis.

Treatment.—The parts should be kept aseptic and dusted with powdered zinc oxide and boric acid.

Warts.—These often arise as a consequence of gonorrhœa, and are pedunculated, which distinguish them from condylomata.
Treatment.—Snip off and cauterize the base.

Horns.—These spring from the body of the gland, and are due to the obstruction of the orifice of a sebaceous gland.
Treatment.—Excision.

Traumatism.—The penis may be injured in various ways. The results, however, are not serious unless the force be sufficient to cause destruction of the organ or injury of the urethra, when stricture will probably follow.

AFFECTIONS OF THE TESTIS, EPIDIDYMIS, SPERMATIC CORD, SCROTUM, AND SEMINAL VESICLES.

CONGENITAL AFFECTIONS OF THE TESTIS AND SCROTUM.

Retention of the Testicle.—The testicle may be arrested in its descent into the scrotum, and may lie (1) in the abdomen, (2) in the inguinal canal. The condition may be unilateral (monorchism) or bilateral (cryptorchism). It is due to an arrest of development, which may be hereditary, or to adhesions.

An arrested testicle is liable to atrophy, malignant disease, cystic degeneration, and, especially when in the inguinal canal, to inflammatory changes. It is therefore wise, when the organ is retained in the inguinal canal, to try and bring it to the normal position by manipulation, which is generally useless, or by operation to fix it in the scrotum. When this cannot be done, or when the organ is atrophied past hope of functional activity, and when it is retained in the abdomen, it should be extirpated.

Misplaced Testis.—The testicle may be misplaced under the skin of the abdomen (**ectopia abdominalis**), to the inner side of the saphenous opening (**ectopia cruralis**), into the perineum (**ectopia perinealis**).

The testicle may also be partially or wholly inverted.

The cause of these conditions is not well understood. It has been suggested that they are due to some excentric attachment of the *gubernaculum testis*.

Treatment.—Except in the case of inverted testicle, the organ had better be removed, as it is usually atrophied, and is liable to injury, and perhaps to take on malignant changes.

Defective Testis.—Occasionally there is complete absence of the testes, or of one of them, most usually the latter. The testicles, though present, may be rudimentary. On the other hand, one or both may be excessively developed (hypertrophy or hyperplasia).

Cleft Scrotum.—The scrotum is sometimes divided into two, each testicle lying in a separate compartment. As a rule the organs are normal.

Congenital Hydrocele.—As the testicle descends from the abdomen into the scrotum, the pouch of peritoneum, which lies in front of the organ, descends through the inguinal canal into the scrotum, where it forms the tunica vaginalis. In the ordinary course of events this sac of the peritoneum, called the "funicular process," is obliterated from the internal abdominal ring as far as the testicle. When it fails to close entirely after the organ has descended, so that there is a communication between the abdominal cavity and the tunica vaginalis, the condition is called "congenital hydrocele"; but is not truly a hydrocele, being rather an imperfect development, whereby the serous fluid of the peritoneal cavity can flow into the tunica vaginalis.

It frequently happens that, just as in congenital hernia, there is no communication with the tunica vaginalis, and the sac containing peritoneal fluid is closed above the testicle.

Diagnosis.—The condition is distinguished from a hernia by the facts that the tumour gives a dull percussion note, is translucent, and does not disappear quickly into the abdominal cavity on pressure, but very gradually diminishes in size, owing to the smallness of the communicating opening. Sometimes a hernia is found to be present in the upper part of the tumour. From an acquired hydrocele it is, of course, distinguished by the fact that the fluid can be returned into the abdominal cavity.

Treatment.—The condition is sometimes cured spontaneously; if not, a truss may be worn. It is not often necessary to operate, since the smallness of the aperture renders occlusion an easy matter.

Torsion of the Spermatic Cord.—This affection is inserted here under congenital conditions, since it seems often to be associated with late descent of the testicles; and even in those cases where the condition is apparently the result of strain, or occurs spontaneously without assignable cause, it is probable that the predisposing cause is some developmental error.

Symptoms.—Sickening pain which persists unless relieved by manipulative or operative interference, till gangrene takes place, when the pain ceases. There is usually pyrexia and constipation. **Absence of abdominal distension and fæcal vomiting** distinguish the condition from strangulated hernia, which it often resembles. The tumour is either in the scrotum or the inguinal region, the enlarged testicle is felt below, while above it is a soft mass consisting of the swollen cord and epididymis.

Treatment.—If seen early, the cord should be untwisted with or without operation, lead and spirit lotion applied, and firm dressing. If seen later, the testicle will have to be removed on account of its gangrenous condition.

INFLAMMATORY AFFECTIONS OF THE TESTIS AND EPIDIDYMIS.

These may be confined to the body of the organ (orchitis) or to the epididymis (epididymitis), and may be acute or chronic.

Acute Orchitis.—Most frequently traumatic, but is met with as a primary affection in gouty and rheumatic persons, and as a sequela

of mumps, typhoid and other of the eruptive fevers, when the epididymis is also involved to a certain extent.

Symptoms.—The classical signs of inflammation, together with a serous effusion into the tunica vaginalis, fever, vomiting, and constipation. Suppuration may occur, and is one of the causes of *hernia testis*. Atrophy may follow owing to the organization of the inflammatory exudate constricting the vessels and tubules.

Acute Epididymitis.—This usually occurs as a result of gonorrhœa, from extension; occasionally follows instrumentation or passage of calculi; and is sometimes secondary to non-gonorrhœal suppurative prostatitis.

Symptoms.—Pain along the course of the vas deferens. The testicle becomes elongated, and the epididymis is easily felt as a swelling surrounding the gland. Suppuration and atrophy sometimes occur.

Treatment.—Rest with supported scrotum and application of evaporating lotions, soon followed by hot fomentations. Antipyretics internally.

In the chronic stage strap the testicle with lead plaster.

Subacute and Chronic Orchitis and Epididymitis may occur as sequelæ to the acute conditions or as a result of trauma. If due to gonorrhœa, the **globus minor is enlarged**; when due to syphilis, the **globus major.**

Tuberculous Disease of the Testis.—This usually occurs as secondary to disease in the epididymis in young adult tuberculous subjects.

The disease generally begins in the connective tissue of the globus major. It may spread to the body of the testis or along the vas, and thence to any part of the genito-urinary tract, and general dissemination follow. It is said that tuberculous disease of the meninges is usually associated with similar trouble in the genito-urinary tract.

Signs and Symptoms.—The affection is generally unilateral. The onset may be abrupt or gradual. When sudden, an acute orchitis is simulated, but is distinguished by the organ remaining enlarged after the pain subsides and by the late formation of an abscess containing cheesy pus. When the onset is more gradual, the epididymis feels nodular; these nodules gradually meet and break down, and the skin becomes involved.

Treatment.—If the case is seen at an early date, when the condition is distinctly local, constitutional treatment may do a good deal to cure the affection, failing which local excision may be practised. If the epididymis is alone involved so far as can be judged, epididymectomy should be performed, especially if the other testis has been removed. The spermatic vessels should be carefully preserved in order to retain the secreting power of the gland. The vas is cut as high up as possible, and the divided end implanted in the parenchyma of the testis.

If the testis be seriously involved it must be removed.

Specific Disease of the Testis.—The testicle is sometimes involved in hereditary syphilis, but it is more usual in the late secondary or tertiary stages of the acquired disease.

As a secondary affection, it occurs as a chronic enlargement of the globus major of the epididymis associated with hydrocele. As a tertiary one, occurring sometimes twenty or thirty years after infection,

PLATE LXXVI.

Tuberculous Disease of the Testicle, showing Caseation and Fibrosis of Epididymus and Body of the Testicle.

(Museum, Queen's University of Belfast.)

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PLATE LXXVII.

GUMMA OF TESTICLE.

(Museum, Queen's University of Belfast.)

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it involves the body of the testis, with a diffuse gummatous infiltration and an overgrowth of connective tissue.

Symptoms.—As a rule, in syphilitic sarcocele the gland is evenly enlarged and **stony hard**, frequently accompanied by hydrocele. Testicular sensation is lost, thus differing from tuberculous disease. The disease may spread to the epididymis and cord. Suppuration is rare, and the gland tissue is gradually replaced by connective tissue.

In the gummatous variety, in addition there are foci which, on section, appear as yellow-white masses, well defined, with soft centres. These gradually involve one part of the organ more than another, so that it becomes irregular.

The testicle may be left apparently normal, or it may be atrophied. In any case its function is more or less interfered with.

Treatment.—Internal treatment with mercury and iodide of potassium and local treatment by strapping, and, if necessary, excision of a gummatous mass and puncture of a hydrocele.

Hernia Testis.—This is a protrusion of the testicle through the skin of the scrotum, and may be due to a septic wound or to acute or chronic suppuration of tuberculous or simple origin.

When not due to tuberculous disease, an effort should be made to retain the organ and close the wound.

Tumours of the Testis.—These are usually malignant. There is, however, one fairly common one which is innocent—**fibro-cystic disease** (adenoma testis). This is a tumour of variable size, scattered through the substance of which are numerous cystic cavities, which are lined with cuboidal or stratified epithelium. The cysts may be round or tubular and communicate with one another ; they contain serous fluid. It is liable to undergo malignant change. The growth probably arises from the mesonephros, and is held to be analogous to cystic disease of the ovary. It occurs between the ages of twenty and forty, and may be started by injury.

Signs.—There is a steady increase in the size of the tumour, which may attain enormous proportions and may be accompanied by great pain, or it may be absolutely painless. The growth is round in outline and elastic on pressure. The cord remains unaffected so long as the growth is innocent.

Treatment.—Remove the testicle after making an exploratory incision. An old hæmatocele has been mistaken for a cystic testicle.

Sarcoma.—Commences in the body of the organ, usually either in the first or fourth decade, and may be a change set up in a late or imperfectly descended testicle.

It may occur as a soft round-celled growth like a lympho-sarcoma, or as a fibro-sarcoma. Cartilaginous nodules are frequently found in the structure of the growth. The soft form is the more malignant.

The growth starts in the connective-tissue elements. It is at first slow, but rapid in the later stages, and occurs as a rounded swelling, at first regular, but later nodulated from the development of cysts. The cord becomes involved at a late stage, and the growth also affects the scrotal tissues, and, bursting through, may form a *fungous testis*, spread to the lumbar glands and internal organs, and, when the scrotum is involved, to the inguinal glands. Testicular sensation is lost, and there is a dragging, heavy sensation. Pain is a late symptom.

Treatment.—Removal of the gland with the cord as high up as possible.

Carcinoma.—Rare, and occurs in late life. The growth springs from the body of the organ. It is a soft, rapidly-growing tumour, which **early** extends to the cord and contracts adhesions to the scrotal tissues. Ulceration follows, and secondary deposits are found in the lumbar and inguinal glands and in the viscera. Very rapid early growth and early involvement of the cord point to carcinoma rather than sarcoma.

Treatment.—Complete removal.

Hydrocele.

By hydrocele is usually meant a chronic affection of the walls of the tunica vaginalis, which produces a collection of limpid serous fluid in its cavity. The cause of the condition may be due to trauma affecting the testicle, gonorrhœa, syphilis, and new growth. There are, however, many cases in which no assignable cause can be ascertained.

The tumour is pear-shaped, with the apex upwards ; it may be very large. In all except very old-standing cases it is translucent ; it is comparatively light, and the testicle can be defined behind the tumour. This point should be remembered in puncturing the hydrocele, and it will aid the memory to bear in mind that the testicle lies behind the peritoneum in the abdomen, and descends in the same relationship, so that the peritoneum which forms the tunica vaginalis must lie in front. There are no **Symptoms** till the hydrocele attains sufficient size to pull on the cord and cause discomfort. Later on the penis becomes displaced to one side, and the pressure of the fluid may cause atrophy of the testicle. Hernia may also develop from traction on the peritoneum.

A hydrocele may be hour-glass in shape or divided in two, owing to a constricting band in the centre. This is sometimes called "bilocular," but the term had better be reserved for the condition shortly to be referred to, where the second sac is within the abdomen.

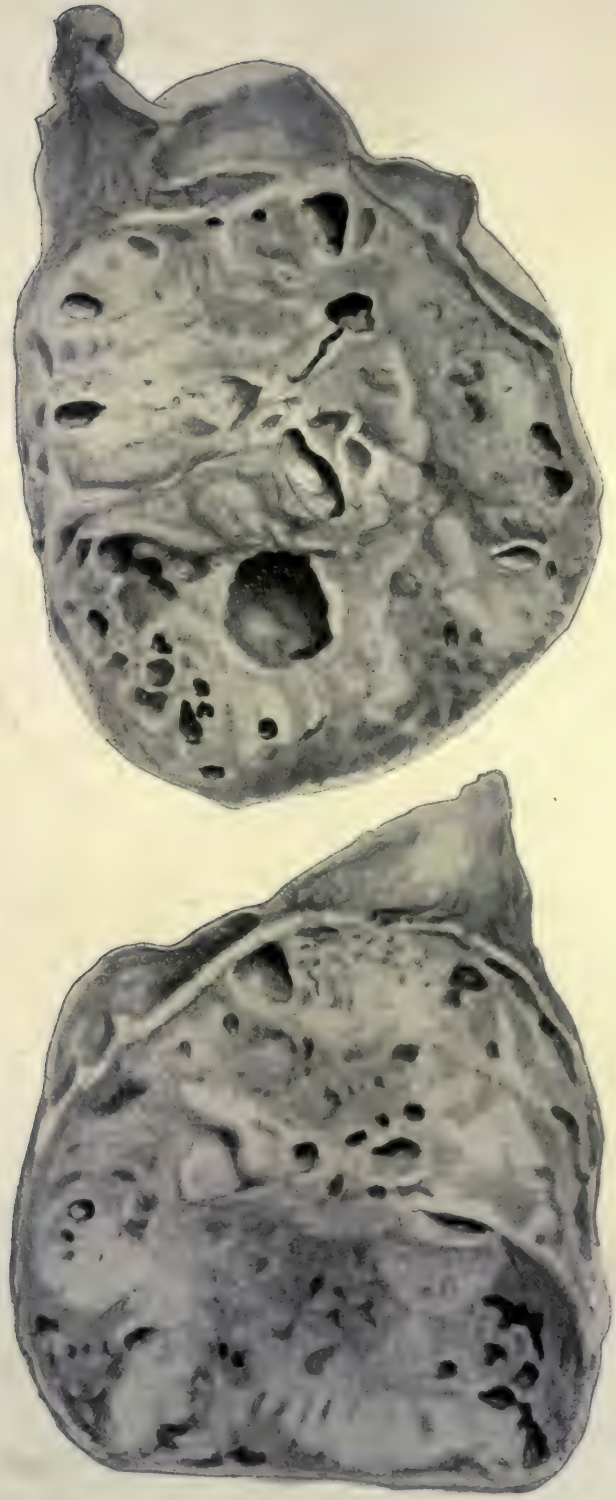
When scrotal hernia develops with hydrocele, its sac usually lies behind the hydrocele.

Diagnosis.—For the most part this is easy, but not always. From scrotal hernia, hydrocele is distinguished by its fluctuating and smooth character, by its dulness, though epiplocele, or even gut which contains no gas, may also be dull on percussion. A hydrocele is usually translucent. Coughing gives no impulse and the tumour cannot be reduced, and as a rule there is a definite termination of the tumour below the external abdominal ring. From tumours of the testicle it is distinguished by its uniform shape, translucency, lightness, and its insensibility on pressure.

Treatment.—By simple puncture made with a medium-sized trocar, which is plunged straight in at a spot clear of veins and then turned up, the back of the tumour and the testicle being held in the hollow of the left hand.

By injection of tincture of iodine or equal parts of glycerine and carbolic acid after the fluid has been drawn off.

By radical operative procedure, in which the skin and sac are



ADENOMA OF TESTICLE WHICH HAS UNDERGONE MALIGNANT CHANGE.

(Museum, Queen's University of Belfast.)

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incised, and the latter cut away, turned inside out, and sutured, or simply sewn to the skin on either side of the incision.

If there is an effusion along the cord, which is rare, it is termed **acute hydrocele of the cord.**

When certain portions of the funicular process usually closed remain unobliterated, effusion is apt to occur, which goes by different names according to the position ; thus—

Congenital Hydrocele.—This is an accumulation of fluid in a funicular process which is patent above, but obliterated below. It produces a swelling in the inguinal canal which simulates congenital hernia. The sac of the hydrocele is identical with that of a congenital hernia of the funicular type, and sometimes communicates with the abdomen by a narrow opening, in which case it is almost impossible to differentiate between congenital hydrocele and congenital hernia in young children prior to operation. Rarely a congenital hydrocele extends to and surrounds the testis, owing to non-obliteration of the lower part of the processus vaginalis, though this is the type usually described as " congenital hydrocele," the same mistake in nomenclature being perpetuated as in the case of congenital hernia.

Treatment.—Consists in separating and ligaturing the neck of the sac, which is subsequently removed. When the lower part of the process is patent, the neck is ligatured without removal of sac, or it is ligatured above and below.

Infantile Hydrocele.—This type is where the process is not obliterated at its lower end, but is at its upper end, and the effusion spreads up to and along the inguinal canal.

Encysted Hydrocele of the cord occurs when the process is obliterated above and below but not along the cord, and the effusion is limited to that portion of the process. It does not require treatment, but may be punctured or dissected out.

Bilocular Hydrocele occurs when there is a sac inside the abdomen, which communicates by a narrow opening with the distended tunica vaginalis.

There is also an **Acute Hydrocele** caused by trauma or gonorrhœal inflammatory extension. Sometimes a chronic case becomes acute. In this condition there is rapid swelling of the scrotum and some constitutional disturbance. The best **Treatment** is rest and elevation of the parts, with the application of evaporating lotion. No puncture is necessary, but if suppuration should supervene, as evidenced by great pain, absence of translucency, and increase of constitutional symptoms, an incision should be made to liberate the contents.

Occasionally, instead of serous fluid, the tunica vaginalis may be distended with (1) milky fluid (**galactocele**—cause unknown) ; (2) with spermatic fluid (**spermatocele**), owing to occlusion of seminal tubules and their distension by semen : this is really a retention cyst, and the fluid is often not inside the tunica vaginalis ; or (3) with blood (**hæmatocele**), as the result of injury.

INJURIES TO TESTIS AND CORD.

Contusion of the Testis.—This is a common injury, and may arise from blows, kicks, or crushing. It is always followed by intense pain locally, and referred to the loins and back. There is usually a good deal of shock, which has been known to lead to a fatal issue.

The remote results of such an accident must be remembered, as orchitis often follows, and may end in atrophy of the organ, or the spermatic vessels may be injured, leading to a similar result.

Malignant disease and tuberculosis of the testis, in those who are predisposed, has been known to follow as the result of crushing of the organ. The testis may also be injured by wounds or punctures, but this is not a very common accident.

Hæmatocele of the Cord.—This is rare. It is usually due to a rupture of one of the vessels owing to strain or injury. When it occurs, a swelling forms along the cord, the testis remaining free. It must be carefully distinguished from a hernia.

Hæmatocele of the Tunica.—This may arise from a blow, a strain, or the wounding of a vessel. The condition must be distinguished from that arising from malignant disease. If seen in the earlier stage, it is not liable to be mistaken for anything else but a hæmatocele, but when it has solidified it may be confused with other sources of enlargement.

Treatment.—If seen at once and there is only a moderate effusion of blood, rest, elevation of the part, and the application of an evaporating lotion, will usually suffice. If the effusion be very large, a portion should be removed by means of a small-size trocar and cannula carefully rendered aseptic, and treatment carried out as indicated. When the condition is old, an open operation is indicated to clear out the blood-clot and to remove the testicle should it have become atrophied.

Rupture of the Vas Deferens.—This may result from great strain, as in lifting heavy weights. It is not likely to be met with, very few cases having been reported. It gives rise to bleeding from the urethra; some fever and atrophy of the organ has been known to follow the injury. If the rupture be in the scrotal portion, enlargement of the testis occurs.

Varicocele.

A very common varicose condition of the veins forming the pampiniform plexus around the cord, rarely affecting those of the testicle, and common to young adult life.

The condition is contributed to by the anatomical arrangement of the parts. The column of blood in the long ascending spermatic vein, formed by the pampiniform plexus, exerts backward pressure, which, in those more prone from personal or hereditary conditions to an atonic condition of the parts, produces varicosity.

It is more common on the left side, owing to—

1. The anatomical arrangement of the left spermatic vein, which empties into the renal vein at a right angle, the right one joining the inferior vena cava at an acute angle.
2. Pressure on the left vein by the sigmoid flexure.
3. The greater length of the vessels on the left side owing to the left testicle being usually at a lower level than the right.

Symptoms.—A dragging, weary sensation in the scrotum, which upon exertion becomes actually painful.

Diagnosis.—This is not difficult. Inspection shows a swelling on the affected side of the scrotum, which is longer and thicker than normal. On palpation the swelling gives the sensation usually described as feeling a number of small worms through a thin bag.

Treatment.—This may be palliative or radical. In mild cases the former may cure the condition. It consists in keeping the bowels well opened by means of a mild saline purge, sponging the part twice daily with cold water, and wearing a well-fitting suspensory bandage. The radical treatment consists in removing a portion of the pampiniform plexus, and bringing the distal and proximal ends together by means of ligature.

Neuralgia of the Testicle.—This condition occurs in young nervous subjects and in gouty old ones.

It is characterized by great pain and tenderness, which is usually paroxysmal.

Treatment.—This consists in a tonic and moral one for the neurotic, and in an anti-gouty one for the elderly subject.

Atrophy of the Testis.—Atrophy has been frequently referred to in the foregoing pages, and it may be well here to summarize its causes:

1. Congenital arrest of development or descent.
2. Inflammatory affection, when it is due to cicatricial bands constricting the vessels; as a sequela of mumps and syphilis.
3. Impaired nutrition from ligature of. or pressure on, the spermatic artery.
4. Chronic congestion, as by a varicocele.
5. Sexual excess is given as a cause, but this may be received with doubt in the absence of any other contributing cause in a healthy individual.

SUMMARY OF DIAGNOSIS OF SCROTAL TUMOURS.

Hydrocele.—A tense swelling within the canal, fixed on holding the testicle, otherwise movable, indicates encysted hydrocele of the cord. Translucent, light, irreducible tumour, without impulse on coughing, which does not disappear on lying down or on upward pressure, indicates hydrocele of the tunica vaginalis.

Hernia.—A reducible tumour which reappears *from above*, with impulse on coughing, resonant (usually) on percussion, not translucent, masks cord and occupies inguinal canal.

Hæmatocele.—When recent: Non-translucent, fluid tumour, irreducible, sudden in origin. When old: Hard tumour with soft centre, history of injury.

Varicocele.—Characteristic feeling of "bag of worms"; disappears on assuming recumbent position, and fills again *from below*.

Orchitis (Chronic).—Testicular sensation present; moderately hard; irregular outline (usually); history of injury, no history of syphilis; anti-syphilitic treatment has no effect.

Syphilitic Disease.—Testicular sensation absent; **stony hard**; regular, smooth outline; limited to body of testis; often accompanied by a hydrocele; suppuration absent; often bilateral; syphilitic history; anti-specific treatment is effectual.

Tuberculous Disease.—In young subjects; epididymis first attacked (usually); cord implicated; hydrocele rare; suppuration frequent; testicular sensation present, except in very advanced cases; often bilateral.

Malignant Disease.—Rapid growth; severe pain; early implication of cord and lumbar glands; unilateral; heavy.

AFFECTIONS OF THE SCROTUM.

Œdema is due, as a rule, to dropsy, and is part of a general anasarca. It is sometimes associated with erysipelas of the part.

Cellulitis is due, as a rule, to extravasation of urine, and may be associated with fistula.

A **Sinus** is met with, as a rule, as a complication of syphilitic or tuberculous disease of the testis.

Eczema is due to pediculi, or occurs as a trade disease amongst workers in tar, paraffin, and soot. The condition is rather intractable, and may end in epithelioma (sweep's cancer), for which complete and wide removal gives hope of cure, since extension is not common till late in the disease.

Elephantiasis, a disease of the tropics, is due to blocking of lymphatics by the *Filaria sanguinis hominis*, in which the subcutaneous tissues are enormously increased in bulk and the skin hardened.

The condition is sometimes due to other causes.

Injuries consist of contusions, which give rise to more or less extensive ecchymosis; and of wounds, which do not differ from those elsewhere so long as the testicle or the epididymis is not injured.

Congenital Cleft has been already referred to.

AFFECTIONS OF THE SEMINAL VESICLES.

Acute Inflammation.—This usually occurs as a complication of gonorrhœa, the infection being carried to the vesicles by means of the seminal ducts. Occasionally it results from a kick in the perineum.

Symptoms.—Resembles prostatitis, and the diseases are often coexistent. Dull shooting pain in the rectum, which radiates towards the perineum. It increases during micturition, defæcation, and coitus. The urine contains pus and blood. Palpation *per rectum* reveals vesiculæ seminales enlarged and tender.

The original cause should be treated, fomentations applied locally to the perineum, and the bowels kept open.

Chronic Inflammation.—Here the symptoms are much more masked, and consist of a feeling of discomfort in the region of the perineum, pain on straining at stool, frequent erections accompanied by involuntary ejaculation. Pus is found in the semen, which, however, retains its vital power.

Treatment.—The cause should be removed if possible. Massage of the seminal vesicles and use of the rectal thermophore alternatively should be employed. The diet should be regulated, and laxatives, urinary antiseptics, and hot sitz baths employed, while sexual quietude is enjoined.

Tuberculosis.—This is a fairly common disease. It is usually secondary to tuberculosis of some other part of the genito-urinary tract or of the lungs.

Diagnosis.—This is extremely difficult at first, till neighbouring parts become affected. There is usually some feeling of fulness and pressure about the anus and perineum, and if the organs can be palpated, small hard nodules are felt above the prostate. If and when the prostate and the ducts are involved, a sign of importance is a yellow-white discharge from the urethra, which, in the absence of gonorrhœa, points to tuberculous disease of the vesicles.

Treatment.—If the disease is more or less isolated—*i.e.*, not in the upper urinary tract or in the lungs—the vesicle or vesicles may be removed, but it is rather a questionable procedure, as it is very difficult to say how far the disease has progressed, and there is the possibility of the lesion, if at all local, being otherwise cured.

Malignant Disease.—This is very uncommon. **Sarcoma**, not diagnosed during life, has been reported. **Carcinoma** is more common, but still extremely rare, and is usually associated with similar disease of the prostate, rectum, or bladder.

Symptoms.—Frequent urination or complete retention are present, the bladder is diminished in size; but these are late symptoms, and the early recognition of the disease is unlikely. Locally a hard tumour is felt above the prostate. Radical treatment is contra-indicated on account of the late diagnosis.

Cysts and **Hydrocele** of the vesicles have been reported.

Seminal Calculi occur, and give rise to disturbance of urination, ejaculation, and defæcation.

Malformation.—Absence of one or both vesicles occurs as a result of arrest of development, and is usually associated with other defects of the genital system. Occasionally the seminal vesicles open into a ureter instead of the urethra.

Injuries.—These are usually surgical, though a kick in the perineum, as already pointed out, may set up acute inflammation.

BIER'S HYPERÆMIC TREATMENT IN GENITO-URINARY SURGERY.

For some disorders of the genito-urinary system it is hoped that this method may be of use, especially in situations or circumstances where other treatment is not satisfactory.

Tuberculosis of Prostate and Seminal Vesicles.—The results of surgical and hygienic treatment of this disorder are not satisfactory. The difficulty of applying the treatment of Bier to the parts is great, and no well-defined plan of action has yet been devised; but it has been suggested that Klapp's suction glasses might be applied to the posterior urethra, and hyperæmia induced in the rectum by means of a special suction apparatus.

Tuberculosis of the Testicles and Epididymis.—Bier's treatment holds out good hope in cases where one testicle has already been removed or where the disease is bilateral, since it obviates the dire necessity of removing both testicles, with the untoward mental changes which follow. Where only one testicle is involved, and especially where the disease is advanced, operative procedure is the wiser course, as danger of infection of the second testicle is lessened by removing the affected organ at once.

Technique.—A soft rubber tube of medium size is passed round the root of the scrotum over a piece of lint, and fastened by means of a clamp. The amount of compression is regulated by the patient's feelings and the appearance of the scrotal skin. The inclusion of a healthy testicle does not do any harm. The tube should remain in place for one hour twice daily, the time being increased if thought advisable.

Treatment by suction glasses may also be applied to the testicle. This method is especially useful when a cold abscess exists. This should be opened and the suction glass applied, the patient's feelings indicating the amount of vacuum to be produced.

In the intervals of treatment a suspensory bandage should be worn.

Willy Meyer points out that the swelling of the epididymis does not often disappear, and that nodules which are present are not tubercles, but are formed of connective tissue.

Tuberculosis of Kidney, Ureter, and Bladder.—For those cases which are suitable for operation, that is the best procedure; but there are many which are not, and for them Bier's treatment by means of suitably-shaped suction glasses applied to the loins, and through the rectum or vagina, holds out some hope of alleviation, if not of cure. This branch of Bier's treatment is still in its infancy, and no doubt some advance will be made in the future.

CHAPTER XXXII

GENITO-URINARY DISEASES IN THE FEMALE

Anatomy of the female genitals—Methods of case-taking and examination—Congenital abnormalities—Accidental injuries—Foreign bodies in the vagina—Injuries during labour—Uterine displacements—Infections of the female genitals—Extra-uterine pregnancy—New growths of vulva, vagina, uterus, and ovaries—Diseases of the female bladder and urethra.

ANATOMY OF THE FEMALE GENITALS.

THE female genitals are divided by the hymen into the internal and external genitals.

External Genitals (Vulva).—These structures surround the **vulval cleft,** which also receives the name of **urogenital space,** as into it open the orifices of the urinary canal (**urinary meatus**) and of the genital canal (**hymeneal orifice, introitus vagina**). They consist of—

1. The **Mons Veneris,** an eminence covered by hair, and situated over the upper half of the pubic symphysis.

2. The **Labia Majora,** two rounded folds of skin extending from the mons downwards towards the anus, covered on the outer side by skin bearing hair, and on the inner by smooth pinkish skin.

3. The **Labia Minora,** or **Nymphæ,** two narrow folds of skin on the inner surface of the labia majora, uniting in front to form the **prepuce of the clitoris,** and gradually blending behind with the inner surface of the labium majus.

4. The **Fourchette,** a transverse fold of skin bounding the perineum in front, usually destroyed at the first confinement.

5. The **Clitoris,** the homologue of the penis, composed of erectile tissue which is divided into two corpora cavernosa and a glans. The organ is attached to the front of the symphysis.

In the angle formed by the converging anterior ends of the labia minora is a smooth space (the **vestibule**), and at the posterior boundary of this space, an inch behind the glans of the clitoris in the middle line, is the **orifice of the urethra,** patent in the multipara, but in the virgin obscured by folds of mucous membrane which overhang and hide the opening. On the urethral aspect of two of these folds, which are situated at the posterior margin of the orifice, and are rarely completely obliterated by parturition, open the ducts of a pair of glands (**Skene's**). The **Urethra** itself is a very dilatable tube of an inch and a half in length, running downwards and forwards, parallel with, and embedded in, the upper wall of the vagina.

Behind the urethral orifice is the **Hymen,** a thin annular or crescentic fold of mucous membrane which narrows the orifice of the vagina, is torn in defloration, and is disorganized by parturition, its remains forming the **carunculæ myrtiformes.** In the angle between

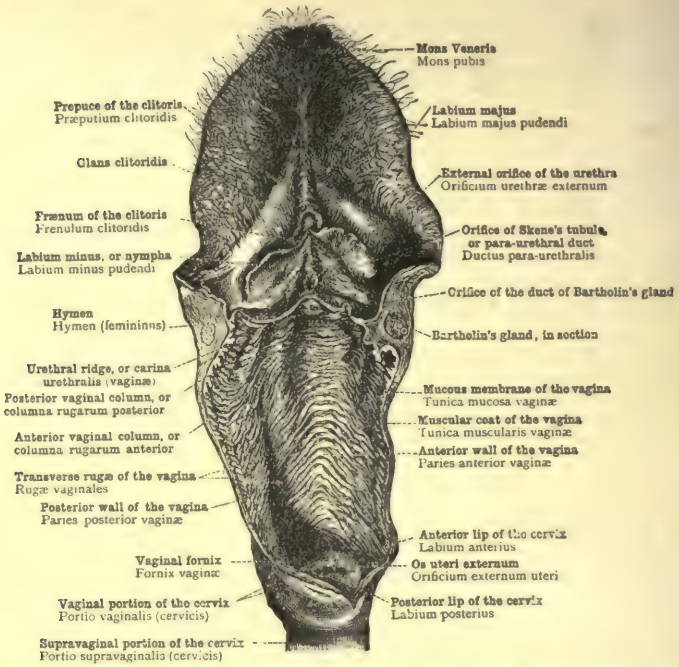

FIG. 113.—FEMALE EXTERNAL GENITAL ORGANS OF A VIRGIN, ATTACHED TO THE VAGINA, WHICH HAS BEEN ISOLATED AND OPENED, AND A PORTION OF THE CERVIX UTERI. HYMEN (FEMININUS). THE VAGINAL FORNIX, WITH THE ANTERIOR AND POSTERIOR LIPS OF THE CERVIX, AND THE OS UTERI EXTERNUM. THE VAGINAL COLUMNS, COLUMNÆ RUGARUM, AND THE TRANSVERSE RUGÆ OF THE VAGINA, RUGÆ VAGINALES.

The posterior wall of the vagina has been divided longitudinally throughout to the left of the median line, and has been turned to the right. Near the vestibule the section passes through the left Bartholin's gland.

(From Toldt's "Atlas of Anatomy.")

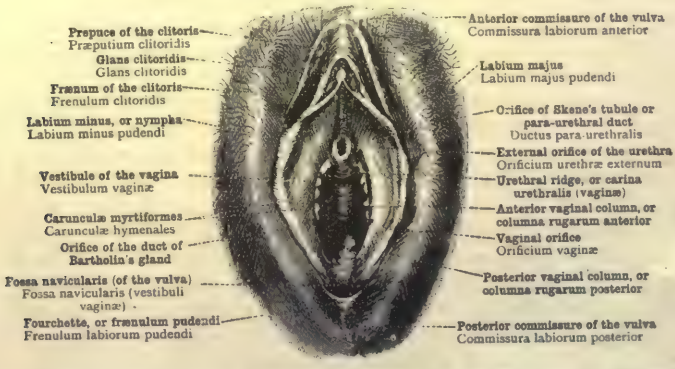

FIG. 114.—VESTIBULE OF THE VAGINA WITH THE LABIA MINORA OR NYMPHÆ, THE VAGINAL AND URETHRAL ORIFICES, AND THE GLANS CLITORIDIS.

The labia majora have been drawn outwards, and the rima urogenitalis, or vulval cleft, has thus been widely opened.

(From Toldt's "Atlas of Anatomy.")

the hymen and the labium minus on either side are the orifices of the ducts of **Bartholin's glands,** which correspond to Cowper's glands in the male, and are situated at the anterior end of the vagina on each side.

The **Perineum** is the name given to the bridge of skin and underlying tissue between the posterior extremity of the vulva and the anus.

Internal Genitals.—The internal genitals consist of—

1. The **Vagina,** a musculo-membranous tube running downwards and forwards, and flattened from above downwards. The upper or anterior wall is about 2½ inches in length, and lies immediately below

Fig. 115.—Median Section of Female Pelvis.
(Bland-Sutton and Giles's "Diseases of Women.")

the bladder and urethra. The lower or posterior wall is about 4 inches long, and in its lower 3 inches is in contact with the anterior wall of the rectum. The upper inch is covered by the peritoneum of Douglas's pouch. At its upper end the vagina encloses the **cervix uteri,** which projects into the canal for a distance of about ½ inch. The recesses in front, behind, and on either side of this projection are known as the **anterior, posterior,** and **lateral fornices** respectively. Laterally the vagina is embraced by the anterior fibres of the **levator ani** muscle. The inner surface of the tube is lined by mucous membrane, each wall is thrown into a central longitudinal elevation (**column of the vagina**) and transverse ridges (**rugæ**). The epithelial lining is of stratified squamous epithelium, and may be regarded as destitute of glands.

2. The **Uterus,** a thick-walled muscular organ, bluntly triangular, and flattened from before back, measures 3 inches in length, 2 inches in its greatest width, and nearly 1 inch in thickness in the virgin, and rather more in women who have borne children. It is usually divided into the **fundus,** or convex upper border; the **body,** tapering gradually to join the **cervix,** which is narrower and more cylindrical than the rest of the organ, is about 1 inch in length, and is inserted into the upper end of the vagina. The **fundus** is completely covered with peritoneum, and is in contact with the intestines. The **anterior surface of the body** is covered by peritoneum, and is normally in contact with the posterior surface of the bladder, the reflection of the peritoneum from the one viscus on to the other forming the utero-vesical pouch. The **posterior surface** is also covered by peritoneum, and is in contact with the loops of intestine occupying Douglas's pouch. The **lateral borders** are left uncovered by the peritoneum, which passes from the anterior and posterior surfaces to the side of the pelvis, forming on each side a peritoneal fold called the **broad ligament,** between the layers of which lie the vessels and nerves of the uterus, the Fallopian tube, and the round ligament, together with a variable amount of areolar and connective tissue, *parametrium*. The upper half of the **cervix** lies in front in relation to the bladder, with which it is connected by loose cellular tissue; on either side it is related to the base of the broad ligament, and has the ureter and uterine artery in close proximity, while behind it is covered by peritoneum. About the level of the middle of the cervix is the line of attachment of the vagina to the uterus, and its lower extremity projects into the canal of the vagina (**portio vaginalis**).

The **uterine cavity** is triangular in form, and flattened so that the anterior and posterior walls are in contact. It is lined by a soft, smooth mucous membrane, the stroma of which is very cellular and is clothed by columnar ciliated epithelium. Simple tubular glands run with a tortuous course down into the stroma, and even down between the muscle bundles of the uterine wall. At the two upper angles of the cavity are two minute openings leading to the canals of the Fallopian tubes, which are attached to the superior angles of the body of the uterus. Below, the cavity ends at the **internal os,** where the **canal of the cervix** commences. This canal is more or less circular in section, and is rather narrowed both at the internal os and at the **external os,** the name given to its termination on the vaginal surface of the cervix. On its anterior and on its posterior wall a longitudinal ridge of mucous membrane is developed, and from this secondary ridges run obliquely upwards on each side, the whole forming the **arbor vitæ.** The lower third of the cervical canal is clothed by stratified squamous epithelium like that of the vagina, the upper two-thirds by columnar ciliated like that of the uterus.

3. The **Fallopian Tubes,** or **Oviducts,** which convey the ripe ova from the ovary to the uterine cavity, are two thin-walled muscular tubes of about 4 inches in length, running from the upper angles of the uterus outwards towards the side of the pelvis in a special fold of the broad ligament known as the **mesosalpinx.** On the side of the pelvis they run with an arched course backwards, upwards, and finally downwards, curving around and above the ovary. Each tube is divided into the **isthmus,** or inner third, with a very narrow lumen; the **ampulla,** or widest part of the tube, forming rather more than half its length; and the expanded, funnel-shaped abdominal extremity, or

infundibulum, which is separated from the ampulla by a constricted opening, the **ostium abdominale.** The infundibulum is prolonged into a number of irregular processes, or **fimbriæ,** and is hence called the **fimbriated end.** One of these fimbriæ is attached to the ovary (the **ovarian fimbria**). The tube is lined by a mucous membrane, which is thrown into numerous longitudinal folds, and is covered by columnar ciliated epithelium.

4. The **Ovaries,** two almond-shaped bodies of about 1½ inches in length, ¾ inch in breadth, and nearly ½ inch in thickness lie against the side-wall of the pelvis on either side in intimate relation to the posterior layer of the broad ligament. At one end of the ovary is the attachment of the **suspensory ligament of the ovary** (**infundibulo-pelvic ligament**), which passes downwards from the brim of the pelvis and contains the ovarian artery and nerves. The opposite pole is attached to the back of the superior angle of the uterus by the **ligament of the ovary.** By its anterior border (**hilum**) the ovary is attached to the back of the broad ligament, and at this point the vessels and nerves enter the organ. The main portion of the ovary, though projecting into the peritoneal cavity, is covered, not by peritoneum, but by an epithelium derived from the germinal epithelium. The intimate structure of the ovary will be described in connection with the section on ovarian tumours.

It will be advisable to add a brief account of the relations to the female genital organs of the bladder and the ureters.

The **Female Bladder** is in relation anteriorly with the back of the symphysis, from which it is separated by loose connective tissue; posteriorly it is covered by peritoneum, and is normally in relation to the front of the body of the uterus. The relations of the base are of most importance. In front it rests upon the upper wall of the vagina, and behind upon the front of the cervix, being connected with these structures by loose areolar tissue. At the upper limit of its connection with the cervix is the line of peritoneal reflection from the bladder on to the uterus (**utero-vesical pouch**).

The **Ureter,** after entering the pelvis close to the point of origin of the internal iliac artery, runs with a curved course downwards and forwards just beneath, and loosely attached to, the peritoneum of the lateral wall of the pelvis, and enters the base of the broad ligament, where it lies about ½ inch external to the cervix uteri, and is crossed by the uterine artery on its course inwards to the uterus. It then comes into close relation with the side of the vagina, and before entering the bladder turns inwards to lie between the anterior wall of the vagina and the base of the bladder.

METHOD OF CASE-TAKING AND EXAMINATION.

History.—The **family history** of the patient is seldom of much importance. The following points in the **personal history** should be noted: (1) **Age**; (2) **married** or **single**—if married, how long; (3) **number of confinements,** how long since last confinement, any **abnormal confinements** (stillbirths, instrumental interference, puerperium prolonged or attended by fever, etc.); (4) **abortions** or **miscarriages**, number, date of last; (5) **menstrual history**, whether attended by pain, and, if so, situation and time of occurrence of pain (before, with, or after establishment of the flow); frequency (especially whether interval has been shortened or lengthened since onset of present illness), dura-

tion and amount (especially whether increased or diminished by present illness), age of first onset of menstruation, date of last period ; (6) presence or absence of **leucorrhœa**, or history of former leucorrhœa (especially important if coming on profusely soon after marriage) ; (7) **painful and frequent micturition** or history of pain and frequency.

In the **history of the present illness** note—(1) Duration ; (2) mode of onset (following confinement, miscarriage, profuse leucorrhœa, etc.) ; (3) presence or absence of pain, and, if present, whether constant or relieved or increased by rest, menstruation, and regular action of bowels ; (4) presence or absence of swelling or tumour—if present, how long noted and whether increasing in size ; (5) whether general nutrition has suffered since illness came on.

Physical Examination.—The usual examination of the heart, lungs, and digestive organs, should precede any special examination. It will in some cases afford a clue to the cause of the complaint, and is necessary in view of the possibility of the surgeon having to decide for or against operative treatment. The surgeon then proceeds to the **Abdominal Examination.** By the usual methods search is made for such abnormalities as distended stomach or intestines, enlarged or prolapsed liver, floating kidney, ascites, and tumour. Should a tumour be discovered, its position and size should be noted, its dulness or resonance on percussion, the condition of its surface (whether smooth, irregular, or nodular), its consistence, and its mobility within the abdominal cavity. Where there is a possibility of pregnancy, careful auscultation for the fœtal heart should be practised.

Vaginal Examination.—This should always be made with care and thoroughness, and in accordance with a regular plan, which will vary with different gynæcologists. I describe that which I use myself. I examine the patient first lying on her back, with the shoulders raised and the knees drawn up, and afterwards lying on her left side, with the left arm behind her back and the knees drawn up against her abdomen (**Marion Sims' position**). Examination should be practised with a rubber glove or fingerstall, as there is risk of the surgeon infecting himself with syphilis in certain cases. It is advisable to inspect the parts before douching, as the presence or absence of a discharge and its character should be verified by actual examination, and not taken on the word of the patient. The labia should be separated with the thumb and forefinger of the left hand, and a careful inspection made of the external genitals and of the introitus vaginæ. The patient should be directed to cough or to bear down, which will disclose any tendency to prolapse of the vaginal walls. Pressure from below should be made on the urethra to detect pus in the canal or in Skene's glands at its orifice. After douching or careful sponging of the introitus, the catheter should be passed, and a specimen of urine taken for examination.

Still holding the labia separated, the surgeon now proceeds to introduce the forefinger of the right hand, or, in the case of women who have borne children, the fore and middle fingers. The cervix is first explored, and its consistency, size, and surface, noted, together with the condition of the external os. The fingers of the left hand are now brought above the symphysis pubis, and are pressed firmly downwards behind the bone, so as to approximate to the fingers inside the vagina, which are directed first in front of the cervix (anterior fornix), then behind it (posterior fornix), and finally to its right and to its left side (lateral fornices). The external hand follows the examining fingers

so as to grasp the different structures encountered between the tips of the fingers of both hands, and so estimate their size, shape, consistence, and mobility.

In order to determine by inspection the condition of the os and cervix, the **vaginal speculum** is used. Three types of examining specula are commonly used : (1) **Sims',** or the **duckbill,** which is perhaps the most generally applicable, but has the disadvantage that in most cases, in order to see the cervix, one hand must hold the handle of the speculum while the other retracts the sagging anterior vaginal wall, so that any manipulation is difficult or impossible without the aid of an assistant. (2) The **bivalve speculum** is intended to obviate this difficulty. The posterior blade, of duckbill type, has hinged on to it a shorter blade, which can be raised by a screw or rack and pinion after the introduction of the instrument, and which serves to elevate the anterior wall and so afford a view of the cervix. (3) **Ferguson's tubular speculum** gives a good view of the cervix, but is rather difficult to introduce in the case of a nullipara. It is perhaps the most convenient instrument in very stout patients with a large deposit of fat on the buttocks and in the labia.

In order to complete the examination, it is sometimes necessary to seize the cervix with volsella, so as to estimate the extent to which it can be drawn down, and incidentally to note whether traction on it gives rise to pain. It may in some cases be advisable to pass the uterine sound, but, as a rule, if a careful bimanual examination is made, the sound can give no further information. The student should remember that both the seizure of the cervix with volsella and the passage of the sound involve breaches of surface, with the possible entry of pathogenic germs, and that a thorough vaginal douche with an antiseptic, in order to remove all septic matter as far as possible, should precede either manœuvre.

The knee-chest position is sometimes useful. The patient rests on the knees and elbows or chest. The pelvic viscera fall downwards towards the anterior abdominal wall, the vagina is ballooned out with air, and manipulation with the speculum is much facilitated.

CONGENITAL ABNORMALITIES OF THE FEMALE GENERATIVE ORGANS.

The student should remember that in the fœtus each **genital gland** (**ovary**) is in connection with the upper end of a tube (**Müllerian duct**), which serves as the **oviduct.** The lower ends of the two oviducts coalesce to form the **vagina**, the middle portions unite to form the **uterus**, the upper ends remain separate and form the **Fallopian tubes**. At its lower end the vagina opens into a skin pouch, the **cloaca,** into which the urethra opens in front and the termination of the gut opens behind. Later the cloaca is divided by a transverse ridge, the future perineum, into a posterior opening for the gut and an anterior opening common to the urinary and genital ducts (the **vulva**). At the anterior end of the vulva is an eminence, the **genital tubercle,** which develops into the **clitoris**, and on each side of it are two folds which form the **labia**. Abnormalities may result from failure of any portion of the tract to develop, or from failure of the normal union between the ducts to take place, or in the case of pseudo-hermaphrodites from undue development of certain of the fœtal elements. These abnormalities are very numerous, but many of them are of merely academic interest. We shall consider the following :

Incomplete Development of the Uterus.—Complete absence of this organ is very rare. It is not, however, very uncommon to meet with cases in which the uterus is represented by a small knob of tissue

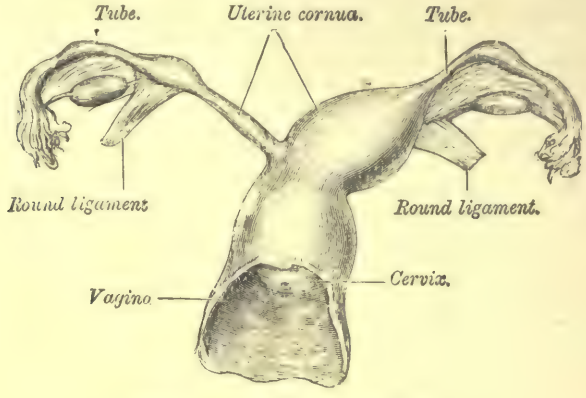

FIG. 116.—UTERUS UNICORNIS.
(Bland-Sutton and Giles's "Diseases of Women.")

surmounting the vagina (**rudimentary uterus**). More common is the **infantile uterus,** which has the cervix long in proportion to the body, and usually conical, with a very small os (pinhole os).

Incomplete Fusion of the Müllerian Ducts.—The ducts may entirely fail to fuse, with **double vagina and uterus** as a result; or the vagina

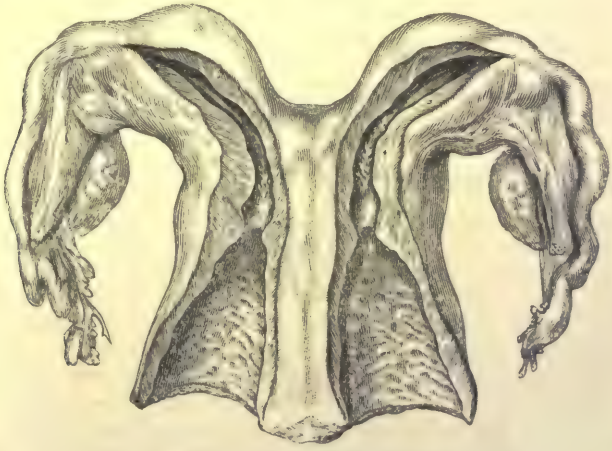

FIG. 117.—UTERUS BICORNIS.
(Bland-Sutton and Giles's "Diseases of Women.")

may be normally formed, but the two halves of the uterus may remain separate (**uterus didelphys**), or but partially united (**bicornuate uterus**). When this abnormality is associated with failure of one or other duct to attain full development, we get the interesting abnormality **unicornuate uterus** or **uterus with a rudimentary horn.**

Symptoms.—Many of these abnormalities do not cause symptoms, and are first discovered when occasion arises for a vaginal examination, perhaps at a confinement. With a **rudimentary uterus** the menstrual flow fails to make its appearance at the time of puberty, although the customary menstrual malaise may be present. **Pregnancy in the rudimentary horn** of a uterus which has only one fully-developed half follows the course of an extra-uterine pregnancy, and is subject to all its dangers.

Genital Atresiæ.—Occlusion of the genital canal occurs as a congenital condition only in the region of the vagina, and may vary from the presence of a thin membrane occluding the lower end of the canal to the replacement of the greater part of the vagina by a fibrous cord.

Fig. 118.—Uterus Didelphys.
(Bland-Sutton and Giles's "Diseases of Women.")

The results of the occlusion are not serious until the onset of puberty. When this has taken place, the normal menstrual discharge of blood is dammed up behind the occlusion, and the vagina becomes distended with altered blood (**hæmatocolpos**). Later the uterine cavity may become distended (**hæmatometra**). The symptoms of such a condition are unequivocal. A young girl at the time of puberty develops all the external signs of puberty, but never has a menstrual loss, though she may have menstrual malaise. If relief is not sought, she soon develops an abdominal tumour, the distended vagina. On examination, the occluding membrane is seen bulging into the vulval cleft, or the absence of the vagina is made out. Free incision should be made to relieve the pent-up blood, and strict antiseptic precautions should

be taken, as there is great risk of sepsis. Atresia may develop in one horn of a double uterus.

ACCIDENTAL INJURIES OF THE EXTERNAL GENITALS, VAGINA, AND UTERUS.

Injuries to the **Vulva** and **Vagina** result from kicks or blows on the genitals, or from falls on sharp or pointed objects. If the skin is broken the **bleeding** is **profuse,** as the parts are very vascular. If the skin is not broken a large **hæmatoma** forms, as the underlying cellular tissue is very loose. Bleeding vessels may be tied, and extensive lacerations brought together with sutures deeply placed so as to compress the surfaces and check oozing. Hæmatomata, unless very small, should be freely incised, the clots turned out, and the cavity packed with gauze.

The most common injury to the **Uterus** is perforation of its wall, either in the attempt to procure abortion or during the operation of curetting, which will be considered later. It is sufficient to say here that the main risk of the accident is sepsis, as, owing to the very free vascular and lymphatic supply of the organ, systemic infection is liable to follow perforation by a dirty instrument, while a peritonitis more or less localized is practically a certainty. The organ is also exposed to injury when prolapsed through the vaginal outlet (procidentia), and instances have been recorded where it has been penetrated by a stab in the abdomen when raised above the pelvis in the later months of pregnancy.

FOREIGN BODIES IN THE VAGINA.

All sorts of **foreign bodies** have been found **in the vagina**, introduced either by way of assault or for the purpose of masturbation. If sharp or pointed they may cause lacerations, which must be treated on antiseptic principles. Removal can be easily accomplished, as the vagina is very dilatable, but an anæsthetic may be necessary.

Retained Foreign Bodies are usually either pessaries which have been neglected, or objects which have been introduced by the patient to serve as pessaries and keep up a prolapse. Instances have been known where such bodies have been allowed to remain for as long as thirty years before advice has been sought. The result of this retention is to set up a vaginitis, and later an ulceration, which may progress to such an extent as to cause fistulous openings into the bladder or rectum. In some cases carcinoma or sarcoma has developed while the foreign body was in the vagina. The **symptoms** complained of are irritation and discharge, and the cause will be ascertained on making a vaginal examination. The foreign body must be removed, and the treatment appropriate for the lesion it has caused should then be instituted.

INJURIES OF THE BIRTH CANAL DURING LABOUR, AND THEIR RESULTS.

The **birth canal** consists of the **cervix, vagina,** and **vulva,** including the **perineum.**

Injuries to the Perineum, Vulva, and Vagina.—Practically every woman in her first confinement gets a tear of the introitus, which

varies in extent from a slight nick of the commissure to a laceration involving the whole depth of the perineum, and extending through the sphincter ani and up the recto-vaginal septum. These tears, if sutured immediately and treated with antiseptic precautions for the first week of the puerperium, usually heal without giving any trouble. If left unsutured, or if allowed to become septic after suture, the torn structures do not reunite, but the raw surfaces cicatrize, leaving a gap in the margin of the introitus of greater or less extent (**ruptured perineum**). When the **sphincter ani** has been divided, and the mucous membrane of the rectum is exposed, the rupture is called **complete;** but when the laceration does not involve the sphincter the rupture is called **incomplete.** Very rarely the child is born through the middle of the perineum (**central rupture**), or the recto-vaginal septum is lacerated without injury to the sphincter ani. The latter accident, if untreated, results in the formation of a **recto-vaginal fistula,** which is more frequently met with as the sequel of a partially successful attempt at the suture of a complete rupture of the perineum. Lastly the **vesico-vaginal septum** may be injured, either by a tear of the cervix extending forwards into it, or by long-continued pressure between the child's head and the symphysis pubis, causing pressure gangrene of the base of the bladder, the result in either case being a **vesico-vaginal fistula.** Besides the breaches of surface already mentioned, two forms of subcutaneous injury occur during labour. The first form, **hæmatoma of the vagina or of the vulva,** is comparatively rare. More frequently the passage of the child's head distends the vagina to such an extent as to dilate permanently or to tear its fibrous and muscular walls, and to weaken the fascial supports which hold them in place, thus preparing the way for prolapse of the anterior (**cystocele**) or posterior wall (**rectocele**).

The immediate treatment of these injuries belongs to the domain of midwifery, but the surgeon is often called upon to repair the damage at a later date. Should immediate suture have been omitted, or should it have failed, it is rarely satisfactory to attempt to get union of the edges of a granulating laceration, and the wisest plan is to allow the raw surfaces to cicatrize, which under antiseptic treatment they will do in from ten to fourteen days. Operation may then be undertaken with every prospect of success. Usually, however, the surgeon sees these injuries at a still later date, when the discomfort caused by the damage done to the parts leads the patient to seek relief, and I shall now consider in detail the more common injuries and the operative treatment appropriate for them.

Complete Rupture of the Perineum.—This injury has as its result more or less **loss of control over the bowel;** but if the patient is inclined to be costive, as most women are, it is wonderful how little discomfort she may suffer, the disability being mainly felt when the bowels are loose, as after an aperient.

On examination, the diagnosis is easily made. The perineum is absent, there is a common cloaca, and just within its posterior margin more or less of the mucous membrane of the rectum is exposed, readily distinguished from that of the vagina by its bright red colour and by its being thrown into folds. The sphincter ani may be felt as a thick, rounded, straight or slightly curved band underlying the junction of skin and rectal mucous membrane posteriorly, and the position of its ends is marked on either side by a deep dimple.

The following **operation** is that usually practised for the relief of

this condition. An incision is made with scalpel or scissors along the **line of junction** of the mucous membrane of **rectum and vagina.** This incision is extended down to, and rather beyond, the dimple marking the position of the end of the sphincter on either side. Incisions are also carried upwards on each side along the **junction of the skin and vaginal mucous membrane.** Starting from the lines of these incisions, the vaginal mucous membrane is raised as a flap from the rectum, the dissection being carried a good half-inch above the apex of the tear in the recto-vaginal septum. Particular care must be

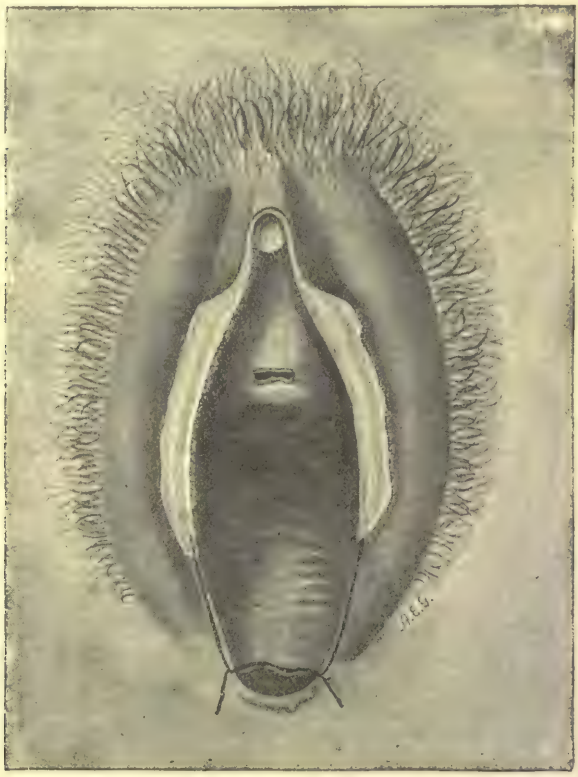

FIG. 119.—PERINEORRHAPHY FOR COMPLETE RUPTURE—LINES OF INCISION.
(Bland-Sutton and Giles's "Diseases of Women.")

taken to lay bare the ends of the sphincter ani at the lower extremities of the incisions. When the flaps have been freed, a line of catgut sutures inserted in Lembert fashion is placed in the margins of the rectal tear, the lowest suture catching the two ends of the sphincter and bringing them together. When this has been done, the remaining raw surface is closed by three or four silkworm-gut sutures inserted as for a perineorrhaphy, or rows of continuous catgut suture may be employed to close the surface in layers. (The first method is illustrated in lower part of figure, the second in the upper.)

Incomplete Rupture of the Perineum.—This accident is often given as a cause of **prolapse of the uterus and of the vaginal walls.** That it

is so is at least doubtful, as many cases are seen where even a very extensive laceration is not followed by any tendency to prolapse, and, on the other hand, prolapse may exist where no laceration, or at most, a minimal tear, is present. The gaping of the vulva which usually follows this injury has, however, the effect of exposing the delicate vaginal mucous membrane to the rubbing of the underclothing; it thus causes discomfort, and it also allows of the ready access of pathogenic germs to the vagina and cervix, and so tends

FIG. 120.—PERINEORRHAPHY FOR COMPLETE RUPTURE—OPERATION HALF COMPLETED.

(Bland-Sutton and Giles's "Diseases of Women.")

to chronic irritation and inflammation. Repair of the perineum in itself has a very limited range of usefulness, and can only be regarded as a cure for prolapse in very mild cases of rectocele or cystocele; but the operation is frequently indicated as part of the operative treatment of prolapse, or, in conjunction with curetting and the repair of a torn cervix, as a cure for chronic cervical endometritis.

On examination, the scar of the tear in the perineum can be made out running transversely at the junction of skin and mucous membrane, and the gaping of the vulval cleft is recognized. An important point is that in most of the more extensive lacerations the anterior

fibres of the levator ani are so stretched or torn that the anus is no longer held forward in its normal position, but is drawn backwards towards the coccyx.

Two methods of repair are commonly practised. In one the raw surface is obtained by dissecting off areas of mucous membrane previously marked out with the scalpel (**denudation**), and in the other by raising up a flap of mucous membrane (**flap splitting**). The modifications of each method are endless; only the two following will be

FIG. 121.—PERINEORRHAPHY FOR INCOMPLETE RUPTURE—SUTURES PASSED, BUT NOT TIED.

(Bland-Sutton and Giles's "Diseases of Women.")

described. Denudation is the historically older method; it more accurately reproduces the original laceration, and it avoids redundancy of mucous membrane. It was abandoned in favour of flap splitting because a loss of a certain portion of tissue was inevitable when the surgeon failed to obtain union; but perfected methods of treatment have made this objection of little force. Flap splitting is a more easy and rapid method of operating than denudation.

The Flap-Splitting Operation (Lawson Tait's).—An incision is made with scalpel or scissors in the centre of the scar. Into this incision one blade of the scissors is thrust, and they are made to cut along the line of junction of skin and mucous membrane first on one side, and then

on the other. The incision when completed is of a **U** shape, and its arms should end at a point on the internal surface of the labium majus about half an inch below the level of the urethra. The centre of the flap thus marked out is seized with forceps, and the vaginal wall is dissected up with scissors from the rectum for a distance of from 1 to 2 inches, care being taken neither to buttonhole the flap nor to cut into the rectum. The ovoid raw surface formed by the underside of the flap and the bed from which it has been raised is then brought together with sutures passing from side to side across it. These are inserted so as just to miss the skin edge, should take a deep bite of the tissues on each side, should emerge for a quarter of an inch in the depth of the wound, and should re-enter on the opposite side, to make their exit just short of the skin. Four silkworm-gut sutures in the bed of the wound are sufficient, and a fifth, which may be of catgut is used to purse together the upper edge of the flap. Either a perineum needle or a half-circle needle held in a needle-holder may be used to pass them.

A Denudation Operation (Emmet modified by Noble).—In a case of healed rupture of the perineum one usually sees in the centre of the posterior wall a raised tongue-shaped projection of vaginal mucous membrane (the vaginal column), with a furrow bounding it on each side. A flap of mucous membrane is dissected off the underlying structures, so as to leave a raw surface of a wedge shape on either side of this central tongue, their apices pointing up the vagina, their bases coinciding with the line of junction of skin and mucous membrane, and united by a denuded strip in front of the point of the tongue, the outline of the area being of the shape of a **W** inverted. The margins of the two limbs of the **M** are united by suture separately, and the raw surface remaining is brought together by sutures passed as in the flap-splitting operation, the uppermost of which ("crown suture") passes through the point of the central tongue of vaginal mucous membrane, and so raises the floor of the vagina to an approximately normal position.

Overstretching of the Vaginal Walls.—In many cases the permanent dilatation of the vagina which results from a confinement is excessive in amount, and is combined with a loosening of the connective-tissue attachments of the tube which permits of its walls becoming more or less everted into the vulvar orifice by the intra-abdominal pressure. The eversion of the **anterior wall,** which is more common, carries down with it the bladder (**cystocele**); less frequently the **posterior** is ballooned forward by the rectum (**rectocele**). Most cases of what is called **prolapse** in practice show one or both of these defects, which may or may not be associated with a true descent of the uterus. The patient usually complains of a "falling of the womb," a feeling of loss of support and of something coming down; irritation and discharge are often present, and in many cases of cystocele there is frequency of micturition and inability completely to empty the bladder.

On examination the diagnosis is made at once by inspection while the patient bears down or coughs. The everted vaginal wall with its contained viscus, bladder or rectum as the case may be, presents at or through the vulva as a rounded tumour.

In many cases of cystocele and rectocele a rubber ring pessary affords much relief. Should the patient desire a cure, operation must be undertaken.

For the relief of **rectocele** the modification of Emmet's operation just described is very satisfactory. The cure of a **cystocele** is often difficult to attain, especially when descent of the uterus is present as well. The operation usually performed is—

Anterior Colporrhaphy.—In the classical operation (Sims') the cervix uteri is drawn down by volsella; an oval piece of mucous membrane is then marked out on the anterior vaginal wall and carefully dissected off the bladder. The margins of the raw area are then united by a line of sutures passing from side to side. Better results, perhaps, are obtained by dissecting off a triangular flap of the vaginal wall, with its apex an inch behind the urethral orifice and its base just in front

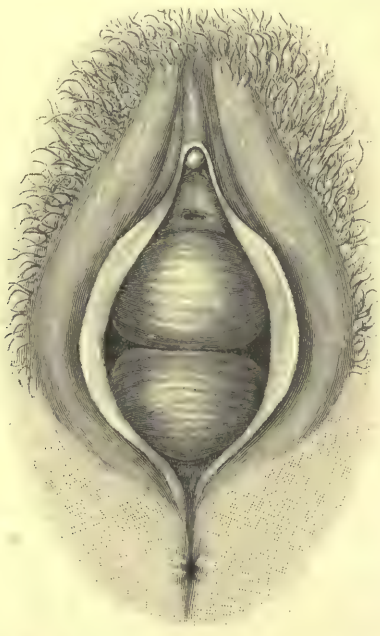

FIG. 122.—CYSTOCELE AND RECTOCELE.
(Bland-Sutton and Giles's "Diseases of Women.")

of the cervix. The bladder is then separated from the cervix as high as the peritoneal reflection, and its base thrown into transverse folds by sutures running from before back, which are passed through the uterine muscle at the level of the internal os, and so take up the slack in the organ and give it a higher attachment. The margins of the denuded area are then sutured in the form of a **Y**. Either of these operations should be supplemented by a perineorrhaphy.

Laceration of the Cervix.—The tear is usually situated on one or both sides of the cervix, and in bad cases extends outwards into the lateral vault of the vagina. Rarely it is anterior or posterior alone, but it is not uncommon to find the lateral tears combined with a third, splitting off a wedge of cervix which projects into the vagina in a polypoid manner. Cases have been reported where the whole cervix

has been torn off as a kind of ring. These injuries, when extensive, heal with more or less retraction of the cervical fragments, so that the canal of the cervix is opened out and its mucous membrane everted towards the vagina (**ectropion**). The surface thus exposed is peculiarly apt to become infected from the vagina (**endocervicitis**), and for the

FIG. 123.—TRACHELORRHAPHY: FIRST STAGE, DISSECTION OF THE FLAPS.

FIG. 124.—TRACHELORRHAPHY: SECOND STAGE, AFTER TYING THE SUTURES.

(Bland-Sutton and Giles's "Diseases of Women.")

cure of this condition it is often necessary to repair the laceration, and so restore the mucous membrane to conditions more nearly approaching the normal. In other cases infection of the tear occurs during the puerperium, and the connective tissue in the base of the broad ligament becomes inflamed. Healing then takes place with the formation of tender bands of cicatricial tissue running out into the broad ligament and underlying the vaginal tear should one exist. The pain caused by these may necessitate the excision of the scar and the freeing of the cervix.

It will be gathered, from what has been said, that a cervical laceration in many cases gives rise to no symptoms, and that when it does the symptoms are not so much referable to the tear in the cervix as to the infection which has been superadded to it, or to which it has predisposed.

The diagnosis is easily made by the finger, and may be confirmed by the speculum. Do not mistake a piece of torn cervix for a polypus, which is softer, or for a malignant growth, which is harder and more friable than the normal cervical tissue. Do not confound **ectropion,** which is strictly limited to the cervical canal and to the torn surface, with **erosion,** which surrounds the os externum and takes the place of the normal mucous membrane of the vaginal aspect of the cervix, though each stands out as a bright red area in sharp contrast with the grey pink of the vagina.

The repair of a torn cervix is known as **trachelorrhaphy,** and is performed as follows : The cervix is exposed through a speculum, and the anterior and posterior lips are caught in volsella, and drawn, the one upwards, and the other downwards. A strip of tissue about ¼ inch in width is removed from the margin of the tear in each lip, care being taken to go well up into the angle of the tear. Catgut sutures are then passed so as to bring the raw surface on the anterior half of the cervix into contact with that on the posterior.

Displacement of the Uterus.—Two forms of displacement of the uterus are found as sequels to parturition. The normal uterus, though it possesses a fairly free range of movement, is anchored in the pelvis in a certain position and at a certain height, to which it tends to return when displaced by external force. This anchorage is mainly effected by four ligaments, two of which—the **round ligaments**—are attached to its superior angles at the junction of fundus and body, are muscular, and by their pull towards their anterior attachment at the inguinal ring tend to maintain the normal forward inclination of the axis of the uterus. The other two ligaments are badly defined and probably vary considerably in development. They consist of fascial bands running along with the uterine vessels from the junction of the cervix and vagina outwards and backwards, to be attached to the pelvic fascia (**ligamentum transversalis colli of Mackenrodt**), and they prevent displacement of the lower pole of the uterus downwards and forwards. In this they are assisted by the **anterior fibres of the levator ani,** and many authorities consider that this muscle takes the chief part in resisting displacement. The supports of the uterus may be affected by pregnancy and labour. The **round ligaments,** which become greatly lengthened as the pregnant uterus grows, may fail to regain their tone, and may permit the fundus to fall backwards into the pelvis (**retroversion**). The **fascial attachments of the cervix** share in the general softening of the pelvic connective tissues which accompanies pregnancy, and their fibres may even be ruptured during labour, while the **anterior fibres of the levator ani** are frequently severed in a perineal tear or are ruptured subcutaneously, accidents which allow of the descent of the uterus towards the vaginal outlet (**prolapse**). It is common to find **retroversion** without **prolapse,** but in practically every case of **prolapse** the uterus is found to be **retroverted** as well. Frequently **cystocele** or **rectocele** is associated with a **prolapsed uterus,** and the term **prolapse** is sometimes loosely used to denote these eversions of the vaginal walls even when unaccompanied by descent of the

uterus. When the condition has lasted for some time, the continuous pressure from above may drive the uterus outside the vulva (**procidentia**), and in such advanced cases as these the cervix is usually lengthened and hypertrophied.

FIG. 125.—RETROVERSION: FIRST STEP IN MANUAL REPOSITION.
(Montgomery's "Gynæcology.")

Retroversion of the Uterus.—This condition arises in most cases as I have indicated, but it may be found as a sequel to pelvic inflam-

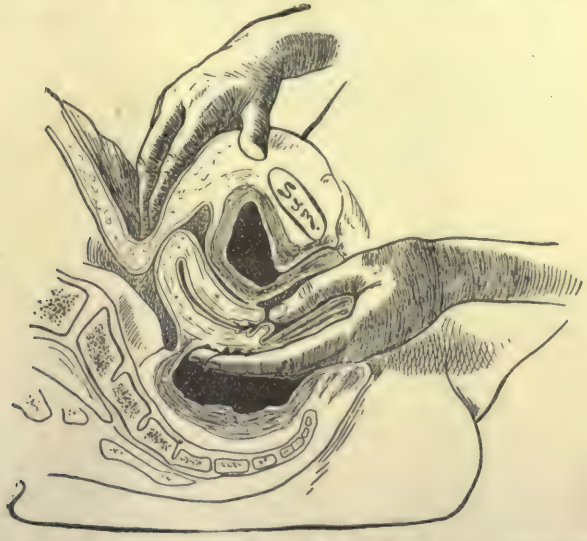

FIG. 126.—RETROVERSION: SECOND STEP IN MANUAL REPOSITION.
(Montgomery's "Gynæcology.")

matory trouble which has resulted in the formation of adhesions dragging the fundus backwards, or even as an apparently congenital abnormality in women who have never borne children and who show no signs of former inflammation.

The **Symptoms** usually associated with retroversion are sacral pain and weight, dragging in the flanks, increased frequency and amount of the monthly flow (**menorrhagia**), and vaginal discharge (**leucorrhœa**). Should a retroverted uterus be discovered in the course of examination of a patient complaining of such symptoms, it must not be too readily assumed that the cause has then been found. Other lesions, such as "erosion," ectropion, endocervicitis, and prolapsed ovary, are frequently present in these cases, and largely account for the symptoms. Treatment should be directed first to the cure of these conditions, and then to the relief of the retroversion which predisposes to and aggravates them.

Treatment.—The object in view is to restore the uterus to its normal position and to keep it there. **Manual reposition** is usually carried out

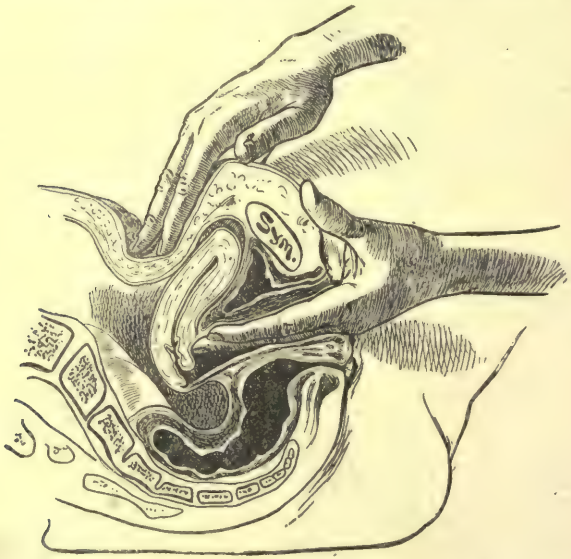

Fig. 127.—Retroversion: Third Step in Manual Reposition.
(Montgomery's "Gynæcology.")

by **Schultze's method.** The patient is preferably placed in the left lateral position, with the knees well drawn up. The index and middle fingers of the right hand are pushed well up into the posterior fornix, and are used to elevate the fundus from Douglas's pouch. The fingers of the left hand make deep pressure through the abdominal wall just in front of the sacrum, so as to support the fundus when raised and prevent it from falling backwards; while the fingers in the vagina are now withdrawn from the posterior fornix and push the cervix backwards so as to restore the axis of the uterus to the normal. This manœuvre is absolutely contra-indicated when there is evidence of pyosalpinx or of ovarian abscess. It may be impossible to raise the fundus on account of adhesions, or because, being congested and big, it accurately fits the bottom of Douglas's pouch and is held there by intra-abdominal pressure; and, further, the anterior vaginal wall may be congenitally so short that the cervix cannot be carried back so as to throw the axis of the uterus into anteposition.

When the uterus has been replaced, a pessary is inserted, preferably a Smith or Smith-Hodge. The narrow end is inserted first, and is carried well up into the posterior fornix, its beak curving behind the cervix, while the broad anterior end presses downwards and forwards against the perineum. The vagina is thus stretched from before back, and, theoretically at least, the cervix is prevented from rotating forward and allowing a return of the displacement.

If the attendant inflammatory or congestive conditions have been first relieved, this method of treatment is often fairly satisfactory, and sometimes even results in a permanent cure of the retroversion. In the majority, however, the displacement recurs even while a pessary is being worn, and return of the symptoms may necessitate operation, which is also indicated where retroversion is complicated by painful peritoneal adhesions, by enlarged and prolapsed ovaries, or by pyosalpinx or ovarian abscess.

FIG. 128.—GILLIAM'S OPERATION, AS SEEN FROM INSIDE OF ABDOMEN.
(Montgomery's "Gynæcology.")

The first step in the operation should consist of **curettage** of the uterus, and **repair of any laceration of the cervix,** should this not have been done previously. The next step is the anchoring of the fundus in the anteverted position. Innumerable operations have been devised for this purpose. In the **Alexander-Adams operation** the peritoneum is not opened, but incisions are made over each inguinal ring, the round ligaments are isolated and drawn out far enough to hold the fundus in anteposition, and are then sutured to the margins of the external abdominal ring. In the operation of **vaginal fixation** the peritoneal cavity is opened through the anterior fornix between the uterus and the bladder, the fundus is hooked forwards, and its anterior surface united by suture to the upper vaginal wall. This operation has now been abandoned, as the fixation of the uterus in this position leads to serious difficulties in subsequent pregnancy and labour. At the present time an operation involving an abdominal incision is most in favour, as this gives an opportunity of dealing with complications

such as intraperitoneal adhesion, prolapsed ovary, and the like, and so affords a better prospect of securing permanent relief of symptoms. The most popular method of fixing the uterus up to within the last few years was that known as **ventral suspension,** in which the fundus is sutured to the peritoneum at the lower end of the abdominal wound, so that a peritoneal ligament is formed, which has the disadvantages of being liable to stretch or to break, and of impeding to a certain extent the progress of a subsequent labour. At present the operation most in fashion is that known as **Gilliam's.** The skin and fat are raised from the anterior surface of the rectal sheath in the region of the

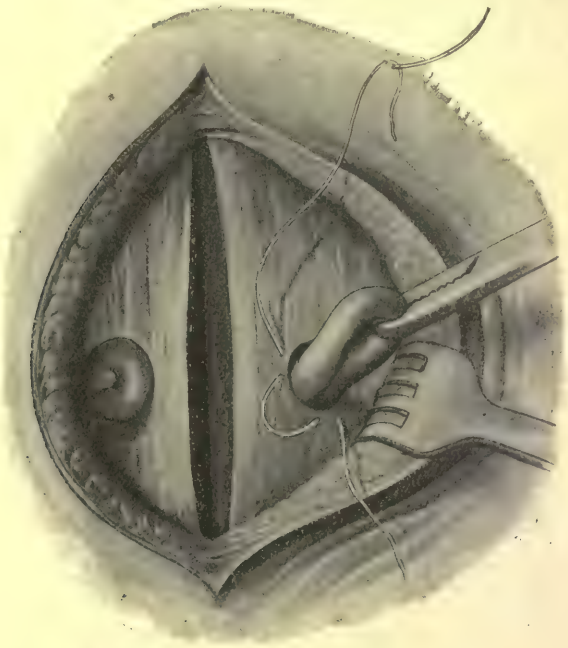

FIG. 129.—GILLIAM'S OPERATION, AS SEEN FROM OUTSIDE OF ABDOMEN.
(Montgomery's "Gynæcology.")

lower half of the abdominal incision; a pair of long-bladed clamp forceps are then thrust through the abdominal wall at the outer margin of the rectal sheath, and the round ligament picked up, drawn through, and fixed by suture to the anterior surface of the sheath.

Prolapse of the Uterus.—The symptoms attributable to this condition are a sense of weakness and a feeling that something is coming down, often more complained of when the prolapse is in its earlier stages than when the uterus is actually outside the vulva. In this latter condition ulceration of the exposed cervix is frequently added to the mechanical discomfort.

Mistakes in diagnosis can scarcely occur if an examination be made, but the student should remember that any abnormal swelling about the genitals is often attributed by patients to falling of the womb,

and that the condition may be simulated by **elongation of the cervix** and by **fibroid polypus of the cervix.**

The **Palliative Treatment** of prolapse consists in the use of pessaries. The form most generally suitable is a ring of sufficient dimensions to stretch the vaginal walls without exerting so much pressure as to cause discomfort. The ring should encircle the os, and the wearer should be instructed to douche daily with a slightly alkaline solution for cleansing purposes, and to have the pessary removed once every three months to be replaced by a clean one. Hard rubber rings are recommended, as less liable to become foul, but if the precautions outlined above are observed soft rubber rings (watchspring) may be used without any bad results, and in some caess with more efficiency. In bad cases of prolapse a simple ring cannot be retained, and a cup-shaped pessary with a stem at right angles to it, and occupying the vagina, is frequently used. Pessary treatment may be inadmissible on account of coincident inflammatory affections within the pelvis, or on account of the pain caused by the pressure of the instrument on a prolapsed and tender ovary, and it may be useless owing to stretching of the vaginal inlet, with inability to retain a pessary of any kind. For any of these reasons, or to avoid the dependence on medical skill involved in the wearing of an instrument, recourse may be had to operation. The choice of operation must be made with due regard to the circumstances of each individual case. A simple perineorrhaphy will never cure a prolapse of the uterus, though it may enable a woman to retain a pessary when she was unable to do so before. In cases of slight prolapse perineorrhaphy must be combined with narrowing of the vagina by anterior or posterior colporrhaphy ; in the more advanced, amputation of the cervix must often be done as well ; while in the most serious forms all these procedures may require to be carried out, and in addition the uterus must be fixed, if a permanent cure is to be obtained. The fixation is preferably done through the medium of the round ligaments (*e.g.*, Gilliam's method) if the patient is still of the child-bearing age ; but if she be past the menopause better results may be expected by fixation between the anterior vaginal wall and the bladder through a vaginal incision, or by fixing the fundus between the recti through an abdominal incision.

Vesico-Vaginal Fistula.—In this condition the patient is unable to control her urine, which usually dribbles away as fast as it is secreted into the bladder. Sometimes, owing to the position or to the small size of the opening, a certain amount of urine can be retained, and may be voided voluntarily ; but even in these cases the fluid escapes as soon as a certain quantity has collected. The constant trickling causes excoriation of the skin of the vulva and thighs, and the decomposition of the urinary solids gives rise to an ever-present ammoniacal odour, so that the life of these patients is one of discomfort and misery.

Constant dribbling of urine is common to this and to the rarer forms of fistula, **vesico-uterine** and **uretero-vaginal**. The hole in the vesico-vaginal septum may be both felt and seen as a rule, but in some cases it is hidden by a fold of the mucous membrane, so that it is necessary to establish the diagnosis by passing a sound into the bladder, and thence through the fistula into the vagina.

Operation for Closure of Vesico-Vaginal Fistula. — The classical method was to pare the edges of the opening, and to suture the raw

surfaces together by a single line of sutures. This method has now been abandoned in favour of a flap-splitting operation. The margin of the fistula is incised all round, and the vaginal wall is freely separated from that of the bladder. The opening in the base of the bladder is closed by Lembert sutures from before back, and the vaginal wall is united from side to side, so that the two rows of suture are only superposed at a single point. In the case of large fistulæ the operation may only succeed partially at the first attempt, and may require to be repeated in order to obtain complete closure.

In **Vesico-Uterine Fistula** the cervix uteri has been extensively torn, and the uterine cavity, bladder, and upper end of vagina, communicate freely. For the cure of the condition the bladder must be separated from the cervix, and each viscus dealt with in turn.

Uretero-Vaginal Fistula is rare as a result of injury during labour, but is not uncommon as a sequel to a wound of the ureter, or to its inclusion in a ligature in the course of an operation, such as vaginal hysterectomy. Should both ureters be involved, all the urine dribbles away, as in the case of a bladder fistula. If one ureter only has been injured, urine flows into the bladder by the sound duct, and is voided in the usual way ; but the patient is kept wet by the urine escaping from the fistula. On inspection, the urine can often be seen escaping in drops or jets from the opening, and the side affected may be determined ; but when the uterus has been removed, and the fistula is seated some way above the level of the cut end of the vagina, so that the urine passes along a channel of some length before reaching the vaginal fornix, it is often necessary to use the cystoscope, in order to be certain which ureter has been injured. Formerly the remedy for this affection was the removal of the kidney on the side affected. Before resorting to such a radical procedure, the surgeon now attempts either to suture the ureteral wound from the vagina—a difficult operation—or to implant the injured ureter into the bladder, which can usually be done with very fair hope of a successful result.

Inversion of the Uterus.—This accident happens during the third stage of labour, and if the inversion be not reduced at once involution of the uterus occurs, with the fundus permanently extruded through the os into the vagina. Less frequently the uterus is turned inside out by the pull of a submucous fibroid growing from the fundus, which draws its seat of attachment after it as it is gradually expelled through the cervix.

The immediate results of the accident at the time of its occurrence are profuse hæmorrhage, and frequently shock. If untreated, the bleeding continues at intervals, there is a mucoid discharge, and the patient complains of a feeling of something coming down. The recent condition is treated of in works on midwifery. When involution has taken place, the surgeon finds on examination that the vagina is occupied by a rather globular tumour, soft in consistence and bleeding easily. On passing the fingers over it, the ring of the external os may be felt around its base, or more rarely the inversion may be so complete that the cervix has also been turned inside out, and the base of the tumour runs smoothly on to the vaginal fornices. Bimanual examination gives the most unequivocal sign of the condition, for by it the absence of the fundus from the abdominal cavity is established, and a dimple may be felt in the abdominal aspect of the base of the tumour, corresponding to the inverted peritoneal surface of the

uterus. By the speculum the tumour is seen to be cherry-red in colour, and the openings of the Fallopian tubes may be distinguished on its surface.

Treatment.—If the condition be fairly recent, an attempt at **manual reposition** may be tried with the aid of an anæsthetic. This is not likely to prove effectual, and recourse should then be had to **repositors.** These instruments have a cup which is placed against the most projecting part of the inversion, and a stem which projects from the vagina, and to which elastic cords are attached. The cords are then fastened to a belt round the patient's waist, so as to keep up constant moderate pressure on the inverted fundus. The apparatus should be regulated every day, and a repositor with a smaller cup may be required to carry the fundus up within the cervix. This treatment should be given a thorough trial for at least a week, and in most cases will prove effectual in procuring reduction. Should it fail, recourse must be had to operation. The method which seems to promise best is **abdominal section,** with incision of the constricted os from within the abdominal cavity to the extent required to permit reduction (Haultain). In some cases the uterus has been amputated, but this must be seldom necessary.

INFECTIONS OF THE FEMALE GENITALS.

Gonorrhœa.—This is by far the most common of these affections. It is due to the gonococcus, and in adults infection is almost invariably by coitus, though the possibility of carriage of infection from one patient to another should be remembered, and should be sufficient reason for the careful sterilization of hands, instruments, and pessaries.

Gonorrhœa of Vulva and Vagina.—The **vulva** is rarely attacked, except in young children or when the skin is macerated by the constant presence of a discharge. The **vagina** is as a rule the part where the infection first gets a hold, and from it the process extends to the **vulvo-vaginal** (**Bartholin's**) **glands** at its orifice, and to the **urethra,** with the glands both along its course and at its meatus (**Skene's glands**). In the acute stage, the mucous membrane of the vagina is reddened and congested, and its surface is bathed in a yellow or greenish-yellow purulent secretion. The urethral infection, which is considered by some authorities the primary one, causes frequent and smarting micturition, and there may be a certain amount of fever and constitutional disturbance. As the process becomes subacute or chronic, the discharge grows paler in colour and more watery, the urinary symptoms subside, the reddening of the vagina is restricted to patches or to points, or may disappear ; but the infection, which is unable to maintain itself on the smooth and glandless epithelium of the vagina, remains entrenched in the recesses of the ducts of Bartholin's glands and of Skene's and the urethral glands.

In the **Treatment** of gonorrhœa it must always be remembered that the danger to be avoided is the spread of the disease upwards to the uterus and tubes ; and, secondly, that any focus of infection left without radical treatment is capable of setting up a fresh attack of the disease. So great is the risk of spreading infection upwards that it is probably best in the acute stage to avoid douches altogether, and to

rely on rest in bed, with cleansing of the external genitals by pads soaked in saturated boracic solution, combined with free purgation and abundant demulcent drinks to relieve the urinary irritation. When the acute stage has passed—say at the end of a week or ten days copious douches may be given of any mild antiseptic, such as permanganate of potash (1 in 2,000), perchloride of mercury (1 in 10,000), half-saturated boracic solution, etc. The douche should be given at body temperature, with little force, and should last for ten to fifteen minutes twice a day. Should the disease resist this treatment, and especially should reddened or granular patches persist in the vagina, the most useful remedy is nitrate of silver solution (20 grains to the ounce), which must be applied either by swabbing the surface after exposure through a speculum or by introducing a Ferguson's speculum up to the cervix, pouring in the solution, and then gradually withdrawing the instrument, so that every part of the vagina comes in contact with the fluid. By these methods the gonococcus will be expelled from the vagina ; but it is much more troublesome to get rid of the gland infection. **Bartholin's gland** may be attacked during the acute stage, with the formation of an **abscess,** which may burst of itself, but usually requires free incision and packing with iodoform gauze. Its duct may become inflamed, and this inflammation may be recognized by the presence of a red and puffy area, somewhat like a flea-bite, around the orifice of the duct on the internal aspect of the labium (**macula gonorrhoica**). In other cases the duct becomes occluded, and the gland is then distended by clear mucoid fluid (**Bartholin's cyst**). Such a cyst is seen as an oval swelling, clearly defined, situated under the mucous membrane of the vulva in its posterior half. The only effectual treatment is to excise the cyst completely, and, as it is very thin-walled, this is rather difficult to do unless the operator lays open the cavity, and then removes the wall entire along with a layer of the subjacent tissues. The glands on the floor of the urethra and Skene's glands harbour the gonococcus persistently, and on examination long after the acute attack has subsided a little pus can be squeezed out of the urethral orifice on milking the tube from behind forward, and a drop can be pressed out of the duct of Skene's gland. The urethra should be treated by swabbing with 5 per cent. nitrate of silver solution, and the same solution should be injected into the ducts of Skene's glands with the blunted needle of a hypodermic syringe, or the duct may be slit up under local anæsthesia and swabbed out.

Vulvo-Vaginitis of Children.—This disease, which is fairly common, is due in the majority of cases to the gonococcus. The infection is, unfortunately, often given purposely, owing to the popular superstition that the disease can be got rid of by communicating it to a virgin ; but in the majority of cases it is accidental, from soiled towels, bedclothes, etc. When the discharge is yellow and purulent, the infection may be looked upon as gonorrhœal ; when it is white, it is the **simple vulvo-vaginitis of childhood,** the exact cause of which is unknown, but which is usually associated with want of cleanliness.

As the ultimate results of gonorrhœal infection in little girls may be very serious, and may lead to permanent disability through the formation of adhesions in the vagina or within the pelvis, treatment should be immediate and thorough. The parts should be mopped with swabs of absorbent cotton, and vaginal injections should then be

given through a large rubber catheter. Nitrate of silver may be required should the disease become chronic.

Gonorrhœal Infection of the Uterus.—Invasion takes place from the vagina by direct extension upwards. Three varieties of mucous membrane may be distinguished in the uterus—a stratified epithelium continuous with that covering the vaginal aspect of the cervix, and extending upwards into the cervical canal for some distance ; ciliated epithelium lining the remainder of the cervix, thrown into folds (the arbor vitæ), and furnished with short wide glands ; and the mucosa lining the uterine cavity proper, smooth-surfaced, covered with ciliated epithelium, and possessing numerous deep and tortuous glands. In many cases of infection the stratified epithelium is replaced by a new growth of microscopic papillæ clothed with a single layer of cubical epithelium, which appears as a bright red area encroaching on the vaginal surface of the cervix (the so-called **erosion**). Infection of the cervical mucous membrane (**acute endocervicitis**) is shown by a greatly increased secretion of mucus, or rather muco-pus, and the surface of the membrane is seen to be deeply congested and covered with adherent secretion. The condition of the uterine mucous membrane has never, so far as I know, been directly observed *in situ ;* but it may be assumed that it resembles that of the cervix. Microscopically, leucocytic infiltration, with dilatation of bloodvessels, may be observed, and the presence of the gonococcus may be demonstrated in the glands and in the secretion. The infection (**acute endometritis**) seldom retains its hold on the body of the uterus for any length of time ; the reason commonly accepted is that the periodic hyperæmia and the shedding of epithelium associated with menstruation get rid of the gonococcus. On the other hand, there is, perhaps, no part of the genital tract where the infection may persist so long as in the recesses of the cervical mucous membrane. The chief thing to be dreaded when the uterus has been attacked by gonorrhœa is the spread of the infection upwards to the tubes and to the pelvic peritoneum.

Symptoms.—Infection of the uterus in the course of an acute attack of gonorrhœa is accompanied by rise of temperature, pain and weight in the back, and a change in the character of the discharge, which, from being serous or sero-purulent, becomes mixed with muco-pus. On examination, the cervix is softened in consistence, and if an **erosion** has developed, a patch giving the sensation of velvet pile will be felt at the os. The uterus is bulky, flabby, and tender. On examination with the speculum, muco-pus may be seen oozing from the os.

Treatment.—The uterus in some cases is able to rid itself of the infection if left untreated, but in most cases the cervix remains chronically diseased. During the acute stage treatment should be limited to copious hot vaginal douches, with sitz-baths and warm abdominal applications to relieve pain and congestion. The bowels should be freely moved. When the temperature has come down to normal, and the disease is in the subacute stage, swabbing out the uterine cavity with a strong antiseptic, such as iodized phenol, pure phenol, or 40 per cent. formalin solution, may be practised, and followed by the introduction of a vaginal tampon soaked in glycerine of ichthyol (10 per cent.). In the chronic stage these measures often require to be supplemented by the removal of the diseased mucous membrane with the curette.

Gonorrhœal Infection of the Tubes and Ovaries.—The infection spreads by direct extension along the mucous membrane of the tube, setting up inflammation (**salpingitis**), which involves the muscular coat, causing it to swell up and engulf the fimbriæ, and so close the abdominal ostium. The closed tube may become distended with pus (**pyosalpinx**). In mild cases the inflammation may subside and leave little permanent damage. If the fimbriated end has been permanently closed by adhesive inflammation, the tube may under these circumstances become distended by serous fluid (**hydrosalpinx**). The infection often extends from the tube to the surface of the **ovary** and to the **pelvic peritoneum**, setting up adhesive inflammation and gluing together the pelvic organs. In addition to the adhesions thus formed, pus may be developed in the substance of the ovary through infection of a Graafian follicle (**ovarian abscess**), or in pockets formed by the adherent organs (**pelvic abscess**).

Signs and Symptoms—1. **Acute Cases.**—In the course of an acute gonorrhœa there are no very definite symptoms which would lead

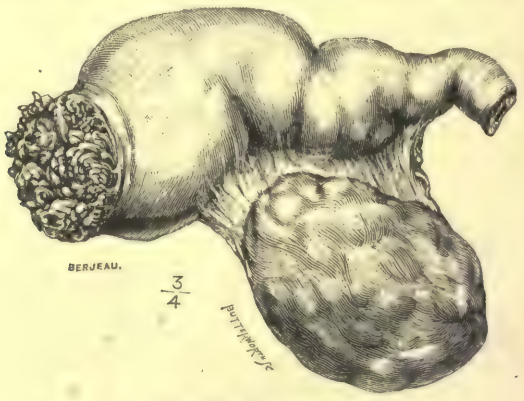

FIG. 130.—PYOSALPINX.
Bland-Sutton and Giles's "Diseases of Women."

to the presumptive diagnosis of salpingitis or of ovaritis. The extension of the inflammation is accompanied by rise of temperature, and in some cases by rigors, and pain, localized to one or both sides of the pelvis, is usually complained of. On examination, local tenderness can be made out, and the swollen tube may be felt as a tender cord on one side of the uterus, or an enlarged and tender ovary may be made out.

2. **Subacute and Chronic Cases.**—The presence of encysted pus, whether in the tube (**pyosalpinx**), ovary (**ovarian abscess**), or between adherent pelvic organs (**pelvic abscess**), may in rare cases fail to produce symptoms for a time, but usually causes well-marked pelvic uneasiness. The patient complains of **pain in the back** or **in the groin,** often radiating down the thigh, and usually more acute at the **menstrual epoch,** which recurs more frequently, lasts longer, and is attended with an **increased loss.** A **leucorrhœal discharge** may or may not be present according to the condition of the cervical endometrium. On examination, the uterus is usually more or less fixed, and masses of infiltration may be distinguished in the fornices. A **pyosalpinx** may be made out as a sausage- or banana-shaped tumour

to one or other side of the uterus, and on a level at its highest point with the pelvic brim. An **ovarian abscess** is more rounded or egg-shaped, and is usually on a level with the upper end of the cervix; while a **pelvic abscess** may occupy the bottom of Douglas's pouch, or may be found in the neighbourhood of the ovary, which not infrequently forms part of its wall. The condition is most likely to be confounded with an **extra-uterine pregnancy,** from which a diagnosis is made by the history of an antecedent infection, the duration of the symptoms, the absence of a missed period and of the characteristic discharge, the presence of fever, and of marked tenderness.

Treatment.—In the **acute stages,** before pus has formed and become encysted, it is questionable whether any good can come of active interference. Certainly in **gonorrhœal** cases, where there is always hope of an ovaritis or salpingitis subsiding without abscess formation, the treatment should be restricted to absolute rest in bed, with frequent hot douches and the judicious use of glycerine tampons. The bowels should be freely acted on, and a sedative may be required for the pain.

In the **subacute** and **chronic** cases, rest, douching, and tampons, should form the main part of the treatment until the temperature has fallen to normal, showing that the pus has become sterile. In order to evacuate the pus and to prevent the risk of a recrudescence of the inflammation, it is necessary to have recourse to surgical means. The abscesses may be attacked either by the abdominal or by the vaginal route. The abdominal incision is usually adopted where there is reason to believe that the pus is confined within a tube or ovary, and the aim of the operator is to remove the affected organ in its entirety without bursting the pus sac. Where double pyosalpinx exists, it is the custom of many surgeons to remove the body of the uterus along with the diseased tubes; but it is in most cases possible to save part at least of one ovary and tube, which can be sutured to the surface of the ovary, and will afford the remote possibility of a pregnancy at some future date if the uterus be left behind. In all cases the pelvis should be drained with gauze through an incision in the posterior fornix.

Many cases of pyosalpinx or ovarian abscess, and practically all cases of pelvic abscess, may be attacked with good hope of success through a vaginal incision in the posterior fornix, which avoids any risk of infecting the peritoneum or the abdominal wound.

Chancre.—The initial lesion of syphilis is usually found on the **labia** or **cervix,** and very rarely on the vaginal wall. As it is hidden from observation in most cases, and causes little pain or discomfort, its existence is often unsuspected by the patient. It may be remarked that the characteristic induration is absent as a rule in chancres of the labium, and that, owing to the moisture of their site, genital chancres in women often develop into **mucous patches** or **condylomata.** An inguinal bubo forms in the case of a vulval chancre, but not with a vaginal or cervical. Diagnosis is often difficult, and it is wise to have the Wassermann test performed in a case of sore upon the female genitals. Treatment is confined to mild antiseptic local applications; blackwash is sometimes useful, and a powder of equal parts of calomel and salol may be used for dusting.

Soft chancres are commonly found on the labium, which is much swollen and inflamed. An inguinal bubo is common. Treatment

should be of an active antiseptic character, and the patient should be kept under observation until after the period of development of secondary syphilis.

Puerperal Infections.—This form of inflammation may follow either **complete** or **incomplete abortion,** or **delivery at term.** It is due in the majority of cases to infection by the *Streptococcus fæcalis*, but the *Staphylococcus pyogenes*, the *gonococcus*, the *Bacillus coli communis*, and the *Bacillus aerogenes capsulatus*, are sometimes causal agents, and often the infection seems to be a mixed one. The various injuries of the birth canal which have been already described may any of them serve as the port of entry for septic organisms, and unless continuous antiseptic measures are adopted a mild local infection is probably inevitable with every laceration of the vulva, vagina, and cervix. In some cases, either through the virulence of the invading organism or the low resisting power of the patient, a more severe type of infection results, and the surface of the laceration may become sloughy and foul, with some constitutional disturbance ; while in the more dangerous forms a generalized infection may ensue, owing to spread of the micro-organisms along the lymphatics or veins. The uterus, if infected, is engorged with blood, and its tissues are softer and more friable than normal. The endometrium is discoloured and injected, its surface is bathed in sero-pus, and sloughing tags of tissue are to be seen at the placental site in fatal cases. Points of pus may be seen scattered over the endometrium and through the muscular wall, and occasionally an abscess forms in the wall. The infection may remain localized, but the tendency is to spread along the numerous lymphatics, and to set up **abscess in the broad ligament** or in the **pelvic connective tissue,** or in the worst forms to originate a **general septicæmia.** Sometimes the uterine veins are infected from the sinuses opening on the placental site. **Infective thrombosis** follows, and the infected clot may then be carried away to set up **metastatic abscesses** and **pyæmia.** In other cases inflammation extends along the tubes, and a **pyosalpinx** or **pelvic abscess** is the result.

Symptoms.—The onset of infection is marked by **rise of temperature** and **rise of pulse-rate,** and **rigors** often occur. The patient feels ill, and pain in the lower abdomen is usually complained of ; but in the worst and most rapidly fatal infections these symptoms may be absent, and a deceptive feeling of well-being on the part of the patient (**euphoria**) may mislead the surgeon. **Tenderness of the uterus** or on one or other side of it can usually be made out by abdominal palpation. Rigidity of the muscles of the lower abdomen may be present at the beginning, and more or less **abdominal distension** usually develops as the disease runs its course. On vaginal examination, there may be remarked a **cessation** of the usual **lochial discharge,** with **dryness and heat of the vagina.** If a perineal laceration is present, there may be tenderness on one or both sides of it. Should pieces of decomposing placenta or membrane be retained in the uterus, **a serous, purulent, or foul discharge** develops. On bimanual examination, the **uterus** is felt to be **enlarged** and **flabby,** and is usually **tender.** Lymphatic extension to the broad ligaments is shown by **tenderness** in one or both **lateral fornices,** and at a later date by the presence of inflammatory thickening. In the later stages abscesses may be detected in the iliac fossa or in the pelvis, or the signs of a systemic infection may be present (see Septicæmia and Pyæmia). Prognosis is very difficult in these

cases, as the most apparently hopeless conditions sometimes get well after a prolonged illness, while patients who have apparently little the matter at first go on steadily from bad to worse, and finally succumb. **A rising pulse-rate** is a bad sign, so are **frequent rigors, rapid abdominal distension,** and the condition spoken of above as **euphoria.** In severe cases the formation of an abscess is often a favourable sign, as it shows that the infection is becoming localized. The patient should not be considered out of danger until the temperature and pulse have come down below 100, and remained so for two or three days.

Treatment.—The uncertain prognosis of this affection makes it difficult to estimate the value of any particular line of treatment, and very many have been tried. Drugs are of little value, but it is advisable to give a smart purge at the onset of feverish symptoms, and quinine in large doses seems to do good. As regards local measures, it is usual to give a copious **douche,** preferably **intra-uterine,** of a weak antiseptic (1 in 10,000 bichloride of mercury, 1 drachm to the pint creolin, lysol, Jeyes' fluid, or other coal-tar derivative), which serves the purpose of washing toxic or decomposing fluids and detritus out of the uterus. Should the symptoms still persist, some authorities prefer to repeat the flushing of the vagina and of the uterus once or twice a day, without attempting more drastic measures. Most gynæcologists, however, make an **exploration of the cavity of the uterus** under an anæsthetic, and remove any loose shreds of placenta or membrane which may be discovered. **Curetting** with a blunt curette is often practised, and the cavity may then be **swabbed with a strong antiseptic,** or lightly packed with gauze impregnated with iodoform or soaked in alcohol or in peroxide of hydrogen solution. Some recommend **incision through the posterior fornix**, with gauze drainage of Douglas's pouch. Heroic measures of doubtful utility are the **ligature of the uterine veins** in pyæmic cases, and the **total removal of the uterus** when the onset of sepsis has been established. Later on in the course of the disease abscesses may require incision, or a pyosalpinx may have to be dealt with. **Antistreptococcic serum** and **vaccine-therapy** may be tried, but the results are not so far very encouraging.

Chronic Endocervicitis, or Cervical Endometritis.—Most of the cases which are known clinically as **endometritis** come, strictly speaking, under this heading. From what has been already said, it will be readily understood that an endocervicitis is often the dregs of an untreated **gonorrhœal** or **puerperal** inflammation of the uterus. In other cases it seems to arise *de novo*, and complicates cases of **retroversion,** of **cervical laceration,** with or without ectropion, and of **perineal rupture,** all of them conditions which predispose to cervical infection, either through interference with the blood-supply, leading to local congestion, or through undue exposure of the cervical mucous membrane to infective organisms by breaches of continuity in the ramparts which normally protect it from contact with the exterior.

The **Symptoms** of the infection are **pain in the back and sides,** aggravated by standing, a feeling of weakness in the pelvis, some tendency to **menorrhagia**, and a **muco-purulent discharge.** On examination, a diagnosis may often be made on observing the stringy muco-purulent discharge. The **cervix** is **softened,** the **os** is often **patulous,** and admits the tip of the finger, even when no laceration is present.

With the speculum the characteristic discharge may be seen oozing from the os, and any **cervical mucous membrane** visible is seen to be **deeply injected.** The **cervix** is **abnormally sensitive;** thus the seizure of it with volsella is painful.

Treatment.—The infection often yields to swabbing with iodized phenol, liquefied carbolic acid, formalin, or the like, followed by the insertion of a glycerine and ichthyol vaginal tampon and the use of an antiseptic douche. In obstinate and recurring cases the uterus should be curetted, and at the same time any laceration of the cervix or perineum should be repaired, and, if necessary, retroversion of the uterus corrected.

Tuberculosis of the Female Genitals.—Tuberculosis of the **vagina** is so rare as to be a pathological curiosity. More common is the infection of the **endometrium** by direct extension from tuberculous tubes. The lesion is at first confined to the area around the tubal opening into the uterus, but may spread ultimately over the whole of the uterine mucosa. The affected membrane is dotted with small yellow-white nodules of caseating tubercle. The chief symptom is **hæmorrhage,** and on examination the uterus may be softened and slightly enlarged, while evidence of the existence of a primary focus in the appendages will be found.

Tuberculous Salpingitis and Ovaritis.—The **tubercle bacillus** frequently attacks the tube, either primarily or as a sequel to disease of the peritoneum, and the surface of the ovary is also infected. The tubercles are found either in the **submucous tissue** or on the **peritoneal surface** of the tube, which becomes thickened and irregular in shape, and is usually covered in by adherent coils of bowel, which may be infected by direct extension. The tube often contains caseous tubercle or tuberculous pus, and one meets often with a **tuberculous pyosalpinx** of considerable size. In most cases which come under observation while the disease is in an active state, the peritoneum is involved. It is probable that the disease is not uncommon in young subjects, and undergoes a process of natural cure, leaving behind more or less adhesion between the tube, ovary, and surrounding organs.

Symptoms.—The disease is commonly seen in young women, who, if married, are usually sterile. **Pain** is not a marked symptom; when present, it is referred to the back and sides. **Dysmenorrhœa** is often complained of, and when the uterine mucosa is involved **menorrhagia** is usual. On examination, the enlarged tubes are felt as indefinite masses on either side of the uterus. The diagnosis from a simple inflammatory swelling or a pyosalpinx may be difficult; the main points on which it is made are the absence of a history of infection at childbirth or of gonorrhœa, the indefinite character of the tumour, and the presence of signs of abdominal tuberculosis.

Treatment.—In the early stages general antituberculous treatment combined with vaccines should be tried, and will often prove useful. Later, when a definite tumour has been formed, an attempt should be made to remove it by the abdomen. If the intestines are much adherent, and are infiltrated with tubercle, it is wiser not to persist in the attempt, as irreparable damage may be done to the softened and diseased bowel wall. The abdomen should be closed, and reliance placed on medicinal measures. Cases thus treated often do well.

For tuberculous endometritis curetting is of little value, but may be

given a trial in the early stages, combined with tuberculin injections and general antituberculous treatment. In advanced cases hysterectomy is indicated, should the patient's health allow of it.

Non-Specific Inflammations of the Female Genitals.

Under this heading I have grouped a number of conditions which may be looked upon as conforming more or less to a chronic inflammatory type, but for which a definite causal infection is either not suggested or not proven.

Senile Vaginitis.—The normal atrophy of the vagina which follows the menopause is associated with thinning of the vaginal wall and smoothing out of its rugæ. In many cases there is some loss of epithelium, and the denuded surfaces coalesce, with the formation of bridges which narrow or occlude the upper end of the canal. During this process there is a thin milky discharge, and on examination patches of hyperæmia may be seen on the vaginal wall here and there. This condition is known as "senile vaginitis," but is of little pathological or clinical significance, except in so far as it may provide a source for anomalous hæmorrhage, which may give rise to a suspicion of cancer.

Kraurosis Vulvæ.—This condition, which may be described as a progressive atrophy of the skin of the vulva, is found in women at the time of the menopause. The patient complains of vulvar irritation, and of pain on coitus or on passing water. The distress is severe enough to prevent sleep and to affect the general health. On examination, the skin of the vulva is smooth and shiny, and injected patches are often present along the margins of the urethral orifice and the carunculæ myrtiformes. Later, the nymphæ atrophy and disappear, the orifice of the vagina is contracted, and the mucous membrane becomes so brittle as to be readily torn in the course of a vaginal examination. The pubic hair becomes scanty.

The condition known as **leukoplakia,** or **ichthyosis vulvæ,** is sometimes confounded with kraurosis, or regarded as an earlier stage of it. It consists of a proliferation of the epithelium covering the clitoris, nymphæ, and adjacent parts of the labia majora, with the formation of white plaques of epithelium, intersected by fissures and cracks. The importance of this form is that it often develops into epithelioma.

Treatment.—For the irritation various sedatives may be tried, the most generally useful being carbolic acid. In the more intractable cases excision of the affected area may be required, and this treatment is especially indicated in the case of leukoplakia, on account of the risk of epithelioma supervening.

Elephantiasis of the Vulva.—In this condition the labia and the clitoris are enormously hypertrophied. The skin covering them is irregular, more or less nodulated, and traversed by fissures and cracks. The cause of true elephantiasis—a tropical disease—is the *Filaria sanguinis;* but a similar condition is sometimes seen in this country as the result of chronic inflammatory affections of the vulva. The treatment consists in a resection of the hypertrophied area.

Vaginismus.—This is rather a symptom than a condition, and is usually found in patients of a neurotic or hysterical type. Any attempt at coitus, or even at the introduction of a finger for purposes of examination, is attended with extreme pain and with spasmodic contraction of the levator ani and of the adductor muscles of the thighs.

That this is not due to abnormal smallness of the parts is shown by the fact that even after dilatation under anæsthesia the symptom persists unabated. On examination, scattered spots of hyperæmia may be seen, and pressure upon these may provoke pain, or a tender tear in the hymen may be discovered; but perhaps more commonly there is no visible evidence of inflammatory trouble or of anything to account for the pain. By examining with a probe one or two spots of tenderness can usually be found, and, as such spots are commonly located on or at the base of the hymen, the treatment that is recognized for this affection is excision of the hymen with its base, and dilatation of the vaginal outlet under anæsthesia, followed, when healing has taken place, by the passage of graduated dilators.

Endometritis ex Abortu—Pathology.—Retained fragments of an ovum may persist for years in the uterine cavity, and set up well-defined pathological changes in the neighbourhood. The retained portions, if large in size, project from the surface of the mucosa and form **polypi.** Their tissue becomes hyaline, and the cells cease to be recognizable. The mucosa in the neighbourhood becomes infiltrated with round cells, and its bloodvessels are dilated.

Symptoms.—The main symptom is hæmorrhage, which may manifest itself as an increased loss at the menstrual period; but usually the bleeding is irregular, with profuse losses at intervals. Should conception occur, abortion usually follows. On examination, the uterus is felt to be more bulky than normal (**subinvolution**); should the retained portion be considerable in amount, the os is often patulous, and readily admits the finger-tip.

Treatment.—Curette.

Hyperplasia of the Uterine Mucous Membrane—Pathology.—In these forms of so-called "endometritis" the mucosa is thickened, in some cases to two or three times the normal. It is usually assumed that any condition that alters the normal blood-supply acts as a predisposing cause of the hyperplasia, and as a matter of fact thickened mucosa is often found in a uterus which is retroverted or prolapsed, which has a fibroid in its walls, or which is associated with pyosalpinx. At the same time thickening of the endometrium may be found in a virgin uterus which is anteflexed, or which has a narrow os, or which is apparently perfectly normal in shape and position. The thickening may be uniform, and of the elements of the mucosa the glands may be elongated and dilated (**hypertrophic glandular endometritis**), or the lymphoid tissue of the stroma may be increased in amount (**interstitial endometritis**), and this may be associated with dilatation of the capillaries (**hæmorrhagic endometritis**). In some cases the thickened endometrium projects into the cavity of the uterus in the form of numerous small rounded polypi (**polypoid endometritis**).

Symptoms.—Most of the ills that female flesh is heir to have been attributed to "endometritis," and as a matter of fact, if one curettes the uterus of a patient who is suffering from neurasthenia or who is run down in general health, it is not uncommon to find in the scrapings microscopic evidence of one or other of the changes just described. If, however, we consider the symptoms which may be directly referred to the condition of the endometrium apart from any malposition of the uterus and from any loss of general health which may coexist, we find that as a general rule these patients suffer from pain and weight in the back, more or less leucorrhœal discharge, and from uterine hæmorrhage in the form of increased frequency of the menses and of an

increased loss, in some cases so profuse as to lead to anæmia. The uterus does not, upon examination, present any very marked change from the normal in shape, size, or consistence, and the diagnosis of the particular form of endometritis present can as a rule only be made from the curetted fragments.

Treatment.—In some cases it is advisable to try first the effect of measures directed to the improvement of the general health and to the cure of anæmia and constipation. Where uterine hæmorrhage is a prominent symptom, too much time should not be wasted on drugs, but the diseased mucosa should be removed with the curette—an operation which may require to be repeated before cure results.

Atrophic Conditions of the Uterine Mucous Membrane.—It is asserted by many authors that in the later stage of **interstitial endometritis** the stroma of the mucosa becomes converted into dense fibrous tissue, with more or less atrophy of the glands, and undoubtedly in some cases we find the amount of tissue which can be removed by the curette reduced to a mere film, while the grating of the instrument shows that it is passing over a surface firmer than the normal uterine muscle. This condition is found in women who are approaching the close of active sexual life, and becomes more common as the menopause draws near. The endometrium is thinned, the glands are less numerous and not so well developed, and often show cystic dilatations, and the bloodvessels are dilated.

Symptoms.—The most prominent symptom is hæmorrhage, which is frequently very profuse.

Treatment.—Every woman who is approaching the menopause, and who complains of excessive or irregular losses, should be curetted without delay, and the scrapings should be examined by a competent pathologist, in order to exclude the possibility of cancer of the body of the uterus. The patient should have the necessity of this explained to her, and may be assured that the operation will not only clear up a point of the utmost importance, but will prove curative, unless a cancer be present.

Arterio-Sclerotic Uterus (Fibrosis of the Uterus).—This form of uterine disease is not very common. It occurs in women of middle life who have borne children, and the main symptom is excessive uterine hæmorrhage recurring every two to three weeks. Curetting, however frequently repeated, is useless, and the only cure is the complete removal of the uterus. The organ is bulky and firm, the endometrium usually thickened, and the arteries thickened and hyaline.

Erosion of the Cervix.—A true erosion or loss of substance of the cervix is not uncommon when that portion of the uterus projects through the vulva (**procidentia uteri**), and is exposed to abrasion. The term is, however, commonly used incorrectly, to signify the replacement of the mucosa around the external os covering the vaginal aspect of the cervix by a new growth (**adenoma of the cervix**—Bland-Sutton). To the naked eye the area affected is of a bright cherry-red ; it bleeds readily on being touched, and gives to the finger the sensation given by the pile of velvet. Microscopically the new growth may present the appearance of papillæ (**papillary erosion**), or of small cystic dilatations of gland tubules (**follicular erosion**), or the cylindrical epithelium of the cervix may extend over the outer surface of the cervix without forming either papillæ or glands (**simple erosion**). The causation is obscure. Some cases are referable to gonorrhœal infection ; some appear in company with cervical lacerations or endometritis ; again,

the characteristic growth may be found in patients with every sign of virginity and no sign of infection of any sort.

Symptoms.—Pain is a constant symptom. It is commonly referred to one or other side of the pelvis, and in unmarried women is often mistaken for ovarian pain until an examination is made. The pain is often increased at menstruation, forming one variety of dysmenorrhœa, and bladder irritation is sometimes complained of. A clear mucoid discharge is usually present.

Treatment.—In my experience, the only treatment of permanent benefit is to dissect off the affected area. Some authors advise the use of caustics, such as iodized phenol.

Curetting of the Uterus.—This simple operation has been frequently mentioned in discussing the treatment of endometritis, and may fitly be described here.

The usual antiseptic preparations for a vaginal operation must be carefully gone through, and an anæsthetic is required in most cases, as, although the actual scraping of the uterus causes little or no pain, the dilatation of the cervix by which it is commonly preceded is a very painful proceeding. After inserting a Martin's operating speculum, the anterior lip of the cervix is caught in volsella and firmly held by the operator, while the handle of the speculum is entrusted to an assistant. Graduated dilators are then carefully introduced through the cervical canal until it has been dilated up to No. 12 of Hegar's scale. The curette, usually a sharp one, although some authorities recommend a blunt one to be used, is then introduced through the dilated cervix, and passed up until it is felt to impinge on the fundus. Its cutting edge is then pressed against the posterior wall of the uterus, and is drawn downwards with successive strokes until the whole of the posterior wall has been carefully gone over. The edge of the curette is then turned, and the same performance gone through on the anterior wall. Where endocervicitis is present, particular attention should be given to the removal of the cervical mucosa, which is apt to receive less thorough treatment than that of the uterus. The uterine cavity may then be washed out with an antiseptic solution through a Boseman's catheter. Some operators then swab it with a strong antiseptic, such as pure carbolic or formalin. Finally a strip of damp iodoform gauze may be introduced for purposes of drainage. After the operation the patient should keep her bed for some days, and should have a warm douche daily for at least a week.

Dangers of the Curette.—1. **Sepsis,** to be avoided by scrupulous antiseptic precautions.

2. **Perforation of the Uterus.**—This accident is perhaps more likely to happen in the process of dilatation, but may also occur during the actual curetting. Perforation is followed by a loss of resistance to the instrument, which can be thrust through the cervix far beyond the normal limits of the uterine cavity, as it is not arrested in its progress by the fundus. Sudden relaxation of the uterus sometimes occurs in cases of abortion while curetting is being carried out, and may be mistaken for a perforation. No harm follows the accident as a rule if strict antisepsis has been observed, and if a flushing curette is not being used. As soon as the fact of perforation is recognized, the instrument should be withdrawn, no attempt at flushing out the uterine cavity should be made, and a gauze drain should be inserted with moderate firmness.

EXTRA-UTERINE PREGNANCY (ECTOPIC GESTATION).

Pathology.—In **normal gestation** the ovum, fertilized in the neighbourhood of the ovary, descends along the Fallopian tube, to become implanted in the uterus and to undergo its further development there. In **ectopic gestation** it becomes arrested before it reaches the uterine cavity, and commences to develop either in the ovary (**ovarian pregnancy**), in the tube (**tubal pregnancy**), or where the tube pierces the uterine wall (**interstitial pregnancy**). The cause of this premature implantation has been referred (1) to **changes in the tube** and adnexa **caused by inflammation** (Lawson Tait and others), a theory supported by the frequent association with extra-uterine gestation of inflammatory changes in the tube, which are, however, by no means constant; or (2) to the **persistence in the ovary or tube of epithelium** capable of undergoing a **decidual reaction** similar in type to the normal reaction of the uterine mucosa in pregnancy, and so of affording a suitable site for implantation of the ovum (Webster), although to this it is objected that a true tubal decidua is, according to most observers, either very scanty in amount or altogether absent in tubal pregnancy. Whatever be the cause, we shall now proceed to trace the results of the abnormal implantation of the ovum.

Ovarian Pregnancy.—It is only of late years that the possibility of true ovarian pregnancy has been universally admitted, and not many cases have been described which conform to the **criteria of true ovarian pregnancy** (Spiegelberg): (1) That the tube on the affected side be intact; (2) that the fœtal sac occupy the position of the ovary; (3) that it be connected with the uterus by the ovarian ligament; (4) that definite ovarian tissue be found in its wall. In these cases impregnation must have taken place within the ovary. Development of the ovum proceeds much as in the uterus, true decidual tissue is not formed, and fœtal life may be prolonged to full term, though it usually ends in the first three months. In some undoubted cases the fœtus disappeared, and the sac took the form of an ovarian hæmatoma containing a few placental villi.

Tubal Pregnancy.—The arrested **ovum** burrows through the epithelial lining of the tube, and commences to develop within its walls, the epithelium and the tissues immediately underlying it thus forming a false decidua reflexa or **capsular membrane** for the developing **ovisac,** from which an ectodermal trophoblast grows out, to be reinforced later by mesoblastic elements, so that ultimately true placental villi are evolved. These fœtal structures eat into the maternal tissues like a malignant growth, and open up or invade bloodvessels, usually leading to hæmorrhages fatal to the ovum and dangerous to the mother. The **tube** itself shows a marked reaction. Its bloodvessels are dilated, its walls thicken, not so much from growth of muscular fibre as from increase of connective tissue and from œdema. Fibrinous degeneration of the elements of the tube around the developing ovum also occurs. In the **uterus** the mucosa presents changes analogous to the decidual formation of normal pregnancy, and the muscular tissue hypertrophies so as to produce marked increase in size of the organ.

Terminations of Tubal Pregnancy.—In practically every case the pregnancy ends in the rupture of the ovisac, often preceded by the death of the ovum.

1. **Tubal Abortion (Intratubal Rupture).**—This is the most common form of rupture, and is the result of the **capsular membrane giving way,** either through perforation by the fœtal villi or through sudden increase of pressure in the sac brought about by the perforation of a

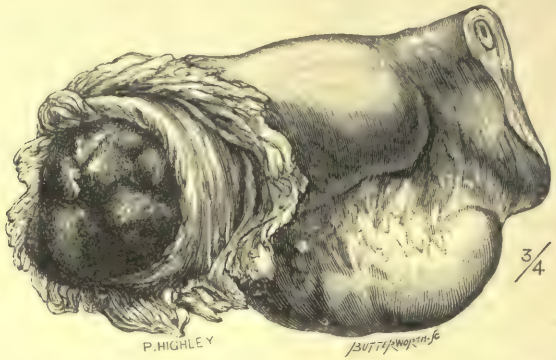

FIG. 131.—TUBAL ABORTION: OVUM IN ACT OF BEING EXTRUDED FROM THE TUBE.

(Bland-Sutton and Giles's "Diseases of Women.")

large vessel. The result in either case is a more or less complete **separation of the ovum from its bed** in the tubal wall, and it may then, if completely detached, be extruded through the fimbriated end into the abdominal cavity, or it may remain partially attached within the tube, become infiltrated and swollen with blood, and converted

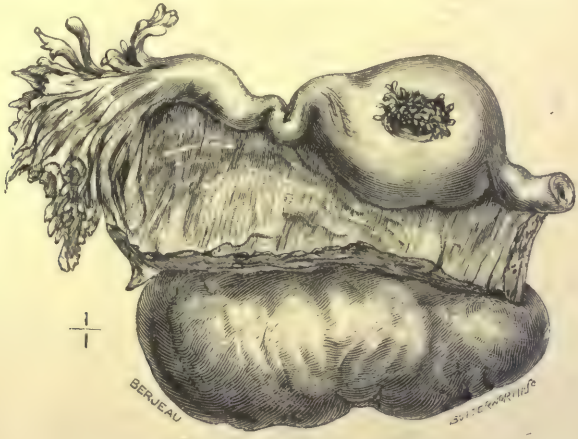

FIG. 132.—EXTRATUBAL RUPTURE.

(Bland-Sutton and Giles's "Diseases of Women.")

into a **tubal mole.** In either case blood is effused into the abdominal cavity, where it may be absorbed if of small amount; but if there is a copious loss, and especially if the flow lasts for a considerable time, a collection of blood forms in the pelvis, bounded by a pseudo-capsule of fibrin firmly adherent to the pelvic organs below and to the intestines above (**pelvic hæmatocele**).

2. **Rupture into the Peritoneal Cavity (Extratubal Rupture).**—The **ovisac** in this variety **ruptures through the peritoneal coat of the tube,** usually at a fairly early stage of pregnancy. Copious intra-abdominal hæmorrhage and extreme collapse usually follow.

3. **Rupture between the Layers of the Broad Ligament.**—This rare form of termination is usually followed by the death of the fœtus and the formation of a broad ligament hæmatoma.

Fate of the Fœtus.—1. In any case of rupture, so long as the placenta has not been dislodged from its site, development may go on to full term, the fœtus lying free in the abdominal cavity, and the placenta growing through the rent in the tube, and attaching itself to the neighbouring pelvic organs and to the intestines (**abdominal pregnancy**).

2. A **dead fœtus** in an early stage of development is **absorbed, and disappears** always if it is extruded into the abdominal cavity, and usually if retained in the tube.

3. A **dead fœtus** of more than three months' development which has reached the abdominal cavity may either become **mummified, skeletonized,** converted into a **lithopædion** by the deposit of lime salts in its tissues, or become the centre of a suppurative process with **abscess** formation, and ultimately the development of sinuses opening on the abdominal wall or into the bladder, vagina, or rectum, through which its bones are gradually extruded.

Signs and Symptoms—1. **Unruptured Tubal Pregnancy.**—Before death of the fœtus has occurred, there are no symptoms which would lead a patient to suspect that she was not normally pregnant. When death of the fœtus has taken place, **uterine hæmorrhage** comes on, **differing from** an ordinary **menstrual flow** in that (1) it appears **after** a four to twelve weeks' **amenorrhœa,** with symptoms of early pregnancy; (2) it is frequently of a **brownish** tint, and mixed with fragments of decidua; and (3) it usually **persists** for a period of ten to fourteen days, or longer. Examination reveals an enlarged uterus, with a doughy swelling in one or other lateral fornix. **Diagnosis** has to be made (1) from an **abortion,** by the absence of fœtus and secundines from the uterine discharge—a difficult thing to be sure of—the absence of "flooding" and clots, and by the presence of an adnexal tumour, which may, however, be inflammatory, or a neoplasm; and (2) from an inflammatory swelling, by the history.

2. **Tubal Abortion (Intratubal Rupture).**—**Pain** on the affected side is usually a marked symptom, and varies in severity from an acute attack, with collapse and extreme abdominal tenderness, to repeated slight pains unattended by general symptoms. The onset of the pain is accompanied by **uterine hæmorrhage** similar in character to that already described. On examination, the findings will depend on the form of abortion which has taken place. If the **tube** has **completely emptied itself,** there may be practically nothing to make out, and diagnosis must depend on the history and the character of the uterine discharge. If a **tubal mole** is present, it can be easily made out, but must be distinguished from other adnexal swellings by the history. Should there be a **pelvic hæmatocele,** a tumour will be felt, which may vary in size from a small fixed mass behind and to one side of the uterus, up to a sac filling the pelvis, bulging into the posterior fornix, and obscuring the fundus uteri. The fibrinous wall of a hæmatocele large enough to surround the rectum causes a constriction of that

tube, which is felt on examination *per rectum* as a characteristic cartilaginous ring at the point where the bowel pierces the pelvic diaphragm.

3. **Extratubal (Intraperitoneal) Rupture.**—The patient is suddenly seized with **acute abdominal pain, tenderness,** and **collapse,** and in addition presents the signs of **internal hæmorrhage,** small rapid pulse, pallor, and subnormal temperature. The presence of free fluid in the abdominal cavity may be made out. Vaginal examination is unsatisfactory on account of the extreme tenderness, and the diagnosis from other causes of acute peritonitis must often be made on the history of **amenorrhœa** of short duration, the **site of onset of the pain,** and the accompanying **uterine discharge.**

4. **Abdominal Pregnancy.**—In the rare cases where the fœtus survives expulsion from the tube, and continues to develop in the abdominal cavity, the patient, after the pain and shock of the rupture has passed off, is often unaware that pregnancy is in any way abnormal. She may have more pain than is usual, the fœtal movements are more distinctly felt, and the fœtal parts can be more clearly made out, while vaginal examination may show that the fœtus lies outside the uterus. This, with the history of severe pain and shock at an early stage of the pregnancy, should suffice for the diagnosis. Should the pregnancy go on to term, false labour sets in, and after lasting a few days passes off. Soon after, the fœtus dies and the placenta shrivels, the mother's abdomen becomes smaller and more flaccid, and the patient feels herself lighter. If suppuration does not take place, the fœtus may remain for years in the abdomen without causing any trouble, and the patient may even become normally pregnant and go through a normal labour.

Treatment.—When **unruptured tubal pregnancy** has been diagnosed the affected tube should be at once removed, as there is grave risk of **extratubal rupture,** followed by possibly fatal hæmorrhage and collapse. When this serious accident has already occurred, the best hope for the patient lies in an immediate laparotomy, in order to remove the ruptured tube and ligate its vessels. The effused blood and clots are then removed from the abdominal cavity, which should be flushed with warm saline and left full of the fluid. In cases of extreme collapse copious saline transfusion may precede operation.

When **pelvic hæmatocele** has formed, some authorities recommend that the case be treated simply by rest in bed, as recovery almost invariably follows, with considerable absorption of the effused blood. Having regard to the length of time required for this result to take place (six to ten weeks), and to the possibilities of continued hæmorrhage and of suppuration, it is better practice to remove the hæmatocele with the disorganized tube, either through an abdominal or vaginal incision.

If the fœtus be alive and gestation has advanced beyond the fourth month, the earliest opportunity should be taken of removing the fœtus and placenta, on account of the risk of hæmorrhage. If, however, false labour has set in, it is probably better to wait a few weeks, to allow of complete occlusion of the bloodvessels of the placenta. The operation before full term is a difficult one, as there is considerable hæmorrhage from the placental site, and to check the bleeding it may be necessary to plug with gauze brought out through the lower end of the abdominal incision.

NEW GROWTHS OF THE VULVA AND VAGINA.

Benign Epithelial Tumours.—The vulva is occasionally the seat of **warts,** which may be simple or gonorrhœal in origin. They are treated by cleanliness, snipping off the warts, and cauterizing the base with glacial acetic acid. In syphilitic cases **condylomata** may develop, and may require to be removed by the scissors or sharp spoon.

Malignant Epithelial Tumours.—Squamous-celled **cancer of the labia** or clitoris is not uncommon. Early involvement of the inguinal glands is the rule, and free removal should be combined with the clearing out of the groin. **Primary cancer of the vagina** is rare, but cancer of the vulva and of the cervix often invade the vagina by direct extension.

Benign Mesoblastic Growths.—Fibromata of the vagina, which may attain a considerable size, are found.

Malignant Mesoblastic Growths.—Melanotic sarcoma of the vulva has been seen, and **sarcoma of the vagina,** but both are rare.

Cysts of the Vagina.—Thin-walled translucent cysts filled with a watery fluid, and varying in size from the bigness of a split pea to that of a walnut, are found on the upper wall of the vagina, and lying a little to one or other side of the median line. They develop from unobliterated portions of the Wolffian duct (Gärtner's duct), and may sometimes be seen on the side of the cervix as well. They may be excised if troublesome. These cysts occasionally become infected and filled with pus ; a piece of the wall should then be snipped out with scissors and the cavity allowed to granulate.

NEW GROWTHS OF THE UTERUS.

Benign New Growths.—Of the epithelial forms, the adenomatous new growth of the cervix, commonly known as " erosion," has already been described. There remain—

Mucous Polypus—Pathology.—Some authors describe this tumour as an exaggerated form of the outgrowths of the mucosa mentioned in connection with " polypoid endometritis," but a mucous polypus is often found growing from a uterus in other respects quite healthy, and is single. It may spring either from the cervix or from the body, and frequently projects from the external os. It is more or less finger-shaped, and is of a dark strawberry colour, soft and succulent, and easily bleeding. Microscopically it consists of a delicate connective-tissue basis well supplied with bloodvessels, and covered by cylindrical epithelium which dips down into elongated and tortuous glands. This epithelium may become flattened, or even transformed into stratified epithelium, in the case of a polypus springing from the cervix and projecting through the os.

Symptoms.—The chief symptom is **hæmorrhage,** irregular in character and often excessive. A **mucoid discharge** is usually present. The diagnosis is made by the finger and by the speculum where the polypus has made its way through the external os. While it is still intra-uterine a positive diagnosis can only be made by the examination of the fragments brought away by the curette.

Treatment.—If the polypus can be grasped, it may be seized in a pair of light forceps and twisted off, the base being then curetted. If it be intra-uterine, a firm curetting will remove it.

Uterine Fibroid—Pathology.—These tumours are found with most frequency in the middle decades of life, from twenty-five to fifty. They occur in both married and single, and in both the barren and the fertile woman. Their origin is unknown, though many pathologists hold that they are developed in connection with the muscular coats of the smaller uterine bloodvessels. A uterus may contain a single fibroid or many. Each tumour is more or less rounded. If not degenerated, it is always firmer in consistence than the uterus, and may be of almost stony hardness. On section it shows a characteristic arrangement of whorled and interlacing bundles of fibres,

FIG. 133.—UTERUS IN SAGITTAL SECTION, SHOWING INTRAMURAL AND SUBSEROUS FIBROIDS.
(Bland-Sutton and Giles's "Diseases of Women.")

whether seen by the naked eye or under the microscope. The tumours may have their seat in any part of the uterus, and clinically it is usual to distinguish a **cervical fibroid,** developing in the cervix; a **submucous fibroid,** developing beneath the mucosa and causing pathological changes in it; an **intramural,** in the thickness of the uterine wall; and a **subserous,** situated just beneath the peritoneal coat. In the process of growth a **submucous fibroid** is apt to grow out into the uterine cavity, and eventually even through the cervix, forming a **fibroid polypus**; and, similarly, a **subserous fibroid** grows out into the peritoneal cavity, forming what is known as a **pedunculated fibroid.** Sometimes a fibroid grows outwards between the layers of the broad ligament—**intraligamentary fibroid.**

Fibroids are very prone to degenerations, and of these the most common is **hyaline degeneration.** The degenerated areas are whitish-yellow in colour, and when examined under the microscope are found to contain few recognizable muscle cells or nuclei, the tissues staining with eosin as a homogeneous mass with a few scattered fibres and nuclei. This hyaline tissue usually becomes œdematous, and by degrees disappears, its place being taken by a quantity of lymph which occupies the meshes of a delicate network of fine filaments, the remains of the original tissue (so-called **myxomatous degeneration**). At a later stage this network is also absorbed, and cavities filled with fluid are left in the tumour (**cystic degeneration**). **Necrosis** occurs not uncommonly, and if the necrotic tumour escapes infection from without, the dead tissue becomes softened, and in some cases caseous ; in other cases lime salts are deposited in it, at first in the form of gritty particles (**calcareous degeneration**), which may eventually become fused into masses of any size up to that of the original tumour (**womb-stone,** or **uterine calculus**). Infection of the necrotic tumour is very apt to happen in the case of a submucous fibroid, especially if it has become pedunculated and has formed a fibroid polypus. Such a tumour is known as a **sloughing fibroid,** and is fraught with much danger to the patient's life, on account of the risk of generalized sepsis. A pedunculated subserous fibroid may become twisted on its pedicle, with the result that a non-infective plastic inflammation is set up, and adhesions are formed between the tumour and neighbouring abdominal organs, including in nearly all cases the omentum. The twist in the pedicle may become so pronounced as to cut off the natural blood-supply of the tumour, and if this has taken place slowly a new supply becomes established by the dilatation of the vessels in the adhesions, and the tumour is nourished from the arteries of the adherent viscus (**parasitic fibroid**). Lastly, some of the cells of a fibroid may undergo a change to a more embryonic type, and become sarcomatous in character (**malignant degeneration**). A combination of carcinoma with fibroid has been observed.

Symptoms.—It is quite possible for a fibroid of even considerable size to produce absolutely no symptoms until its size causes the patient to notice it. In the ordinary course of events the two most prominent symptoms of fibroid are **hæmorrhage** and **pain**. **Hæmorrhage** is a symptom of a submucous fibroid, and is due to changes in the endometrium covering it, which becomes stretched and thinned out by the growth of the tumour ; the glands atrophy and disappear, and in the most advanced cases the surface epithelium itself may be lost and the tumour may be exposed in the uterine cavity. The bleeding as a rule comes from the mucosa, and at first occurs as an increased menstrual loss, which may be very great in amount. Later the losses may occur independent of the menstrual period. In rare cases a vein coursing over the surface of the tumour may give way and lead to hæmorrhage. **Pain** is felt under the following conditions : (1) As a **result of the pressure** of the tumour on neighbouring organs, most likely to occur while the growth is still contained in the pelvis, and before it has risen into the abdomen ; (2) as **dysmenorrhœa,** due to the **formation of clots in the uterine cavity,** and to their expulsion by painful uterine contractions ; (3) as the **result of changes in the tumour,** such as twisting of the pedicle of a pedunculated myoma, sloughing of a submucous tumour, or the peculiar change in a fibroid seen most commonly during pregnancy, and known as **red degenera-**

tion. Apart from pain, patients often complain of a feeling of **weight and dragging** in the pelvis, due to the mere size of the growth. Another symptom which is present in many cases is **frequency or pain in micturition,** due to the pressure of the growth on the bladder.

Relation of Fibroids to Pregnancy.—The majority of patients who have fibroids are sterile. Should pregnancy occur there is an increased risk of abortion, and if abortion does not take place the tumour grows at a much more rapid rate than normal, and pain is commonly complained of. Labour is not likely to be interfered with unless the tumour be situated in the cervix, but there is considerable risk of sloughing of the fibroid during the puerperium, with much danger to the patient from sepsis. Should this risk be avoided, the tumour usually involutes along with the uterus and becomes smaller, and cases have been reported where a fibroid is said to have disappeared altogether after pregnancy.

Fibroids and the Menopause.—The presence of fibroids as a rule delays the onset of the menopause. There is a tendency to believe that this event is likely to be followed by shrinking and disappearance of the tumour ; but there is little evidence in support of this view.

Physical Signs and Diagnosis.—It will be readily understood that in an affection so protean as uterine fibroid the physical signs are far from constant. When the tumour has grown large enough to be felt above the pelvis, we have the abdominal signs of a swelling which may just be felt above the symphysis, or may reach up to the ensiform cartilage, according to the extent of its growth. The tumour is **dull on percussion,** is usually more or less **irregular and nodular** of surface, **firm** in consistence, and **non-fluctuant,** except in those rarer cases where extensive softening has caused the formation of a large cystic cavity. The growth is usually **movable** from side to side in the abdomen, and this is specially marked in the case of a pedunculated subserous fibroid ; mobility may be impaired by extensive intra-abdominal adhesions or by the pelvic portion of the tumour fitting accurately into the pelvis (**impaction**). On examining the vagina, the canal may be normal or may be altered in direction if the fibroid has developed in the lower part of the uterus or in the cervix. Should a cervical fibroid be present, the alteration in contour of the cervix will be felt, and a fibroid polypus which has passed the os will be easily recognized. Careful bimanual examination will establish the continuity of the tumour with the uterus, and reveal intrapelvic growths, if present. The time-honoured passage of the sound, with manipulation of the abdominal tumour, can give no further information to one who is skilled in bimanual palpation.

Diagnosis from Pregnancy.—(1) The history is of importance, **amenorrhœa** being **absent** in fibroid. (2) The vagina has no bluish tinge in fibroid, though dilated veins may be present. (3) The **cervix is not softened,** nor is there softening of the lower uterine segment, as in pregnancy. (4) The uterine tumour is harder than the pregnant uterus, unless extreme cystic degeneration is present, and **neither ballottement nor alternate contraction and relaxation** are to be made out. (5) There is **no fœtal heart nor fœtal parts** to be made out. Should there be any doubt, it is well to postpone interference for a month or six weeks, as (6) the pregnant uterus will grow in the time enormously faster than any tumour could possibly do. The possibility of a combination of pregnancy and fibroid should not be lost sight of, though in the case of a uterus much deformed by numerous tumours

it is often impossible to diagnose an early pregnancy from the physical signs, and the history alone will be likely to lead to the right track.

Diagnosis from Ovarian Cyst.—(1) Cysts are of more rapid growth, and do not cause hæmorrhage or pain as a rule. (2) They are **more smooth and uniform** of surface, and give fluctuation. (3) On bimanual examination, the **uterus** can be made out **distinct from the tumour,** which in the case of a large cyst usually sits above the pelvis, leaving it empty. A pedunculated subserous fibroid may be indistinguishable from an ovarian tumour.

Chronic tubal disease has been mistaken for fibroid, but should be differentiated by greater tenderness on pressure and by its characteristic outline and relation to the uterus. A **pelvic kidney,** or even a **hypertrophied spleen,** have been mistaken for uterine tumours.

Treatment.—While it may be admitted that a small subserous fibroid which has never given rise to symptoms, and is discovered in the course of a routine examination, may be left alone without treatment, I think the feeling of almost every gynæcologist at the present day is that, **as soon as a fibroid has begun to cause symptoms, its early removal is the best treatment possible for the patient.** Should she be very anæmic or have suffered recently from a large hæmorrhage, it will be advisable to confine her to bed and to improve her general condition by suitable drugs and feeding before attempting operation. Should she be pregnant, the decision of interference or not will depend on the urgency of the symptoms ; but **in all cases complicated by pregnancy operation should be looked on as a last resource,** and, if possible, enucleation of the fibroid rather than hysterectomy should be attempted, in the hope that gestation may go on to term.

The **choice of operation** depends on the number and situation of the tumours. Where a **subserous pedunculated myoma** is alone present, the tumour is removed with ligature of the stalk and no interference with the uterus. Where we have to deal with a solitary or apparently **solitary intramural or submucous growth,** enucleation (**myomectomy**) may be done. This operation is performed in the case of a **cervical fibroid** by cutting into the tumour with knife or scissors, and removing it piecemeal with sharp gouge forceps (Schultze's spoon forceps). To attack a **small submucous tumour** in the body of the uterus, the uterine cavity is laid open by an incision in its anterior wall, and the fibroid dealt with by scissors and spoon forceps. Hæmorrhage can be checked by firm packing with iodoform gauze. **Abdominal myomectomy** is the method of election **for fibroids situated in the fundus,** not too large in size or too numerous. The uterus is exposed and drawn out through an abdominal incision, which is then packed with gauze to prevent escape of intestines. An incision is made through the uterine muscle, the tumour is shelled out, and the cavity obliterated by rows of catgut sutures. Myomectomy is in general a more difficult and rather more dangerous operation than hysterectomy, which will be next described. It should be reserved for cases where the patient is still of the child-bearing age, and where it is important that she should remain capable of pregnancy. It is contra-indicated when the uterus is much deformed by large and numerous tumours, when the case is complicated by the presence of pus in the tubes, or where the patient is much pulled down and very anæmic.

Hysterectomy (**Hysteromyomectomy**).—The entire uterus may be removed (**total hysterectomy**), or it may be amputated just above or

through the cervix (**supravaginal hysterectomy**). The latter operation is that more commonly performed, and is indicated in all cases except when a cervical tumour is present or there is a suspicion of malignant disease, when the complete removal of the uterus should be carried out. The method most usually adopted is that introduced by Howard Kelly, and called by him the **left to right** method, which will be now described.

The abdomen is opened by an incision, which should extend from an inch above the symphysis to a point high enough to enable the tumour to be easily delivered. The uterus with its attached tumours is then drawn up out of the abdomen—a step which may be attended with some difficulty, especially where the tumour is mainly pelvic. The operator then ties the left round ligament and divides it. He then ties or clamps the ovarian vessels outside the ovary if that organ is to be removed with the uterus, and inside if it is to be left. The division of the left broad ligament frees the left side of the uterus as far as the uterine vessels, and the next step is to separate the bladder from the front of the uterus. In doing so a cuff of peritoneum of half an inch in breadth is left attached to the bladder. The left uterine artery is now clamped with forceps, and a section of the cervix is made. This section should be so made that the cervical stump is left hollow either from before back or from side to side. When the last fibres of the cervix are divided, the uterus, which has been pulled strongly over towards the right, is freed, and can be rolled out of the abdomen. The right uterine artery can now be clamped and divided, and the removal of the uterus is completed by clamping or tying the right ovarian vessels and severing the right broad ligament. The clamped uterine vessels are now tied and any bleeding-points secured. The cervical flaps are brought together with sutures, which check all oozing from the raw stump ; and lastly the peritoneum is united over the raw surfaces left by the cutting of the broad ligaments, and the cervical stump covered with the peritoneal flap left attached to the bladder. Some operators fix the ends of the round ligaments to the cervical stump to guard against prolapse.

In the older operation the round ligament, ovarian vessels, and finally the uterine artery, are ligatured and divided on one side. The operator then goes through the same procedure on the opposite side, and finally severs the body from the cervix. The last stages of the operation are carried out in practically the same manner as in the Kelly method.

Supravaginal Hysterectomy, with Bisection of the Uterus.—In some cases the size of the tumour or the impossibility of getting it up so as to leave the pelvis clear renders it difficult or impossible to reach the uterine artery on either side. In such cases the operation is made possible or much simplified by bisecting the uterus with its contained tumours after freeing the bladder. When the cut has reached the level of the cervix, each half of the body in turn is severed from the cervix and turned outwards, and the uterine and ovarian vessels are secured from below upwards, plenty of room and good exposure being obtained. This method should, however, be reserved for cases such as have been indicated, as it is distinctly more dangerous to the patient.

Total Hysterectomy.—In performing this operation, it is best to tie each vessel as it is encountered, commencing with the ovarian and the round ligament on one side, and dissecting down until the uterine is

reached. This vessel is tied by passing a needle armed with a ligature under it and close to the cervix, so as to avoid injury to the vessel itself or to the ureter. The artery is then severed, and the dissection carried down to the insertion of the cervix into the vagina. The opposite side is treated in a precisely similar manner, and it is then easy to cut through the attachment of the vagina to the cervix and to remove the uterus. Bleeding from the cut edge of the vagina is checked by whipping with catgut, and the peritoneum can either be brought together over the stump or an opening left for a gauze drain should there be any suspicion that the uterine or vaginal cavities are not sterile.

In **Doyen's method** of performing this operation, the uterus is drawn strongly forwards, and the operator begins by making an incision into

FIG. 134.—A UTERUS IN SAGITTAL SECTION, SHOWING DIFFUSE ADENO-MYOMA, FROM A SPINSTER THIRTY-TWO YEARS OF AGE.
(Bland-Sutton and Giles's "Diseases of Women.")

the vagina through the posterior fornix, which may be made prominent by passing a pair of long forceps into the vagina. The cervix is then seized with strong volsella, drawn upwards into the abdomen, and freed from its vaginal attachments from below up, the dissection keeping close to the surface of the uterus. The vessels are clamped as they are met with, and the bladder is peeled off the front of the uterus from below up. This method has the advantage of being very rapid.

Preservation of Ovaries in Hysterectomy.—In many cases of fibroid the ovaries and tubes are diseased. Where this is the case, it is, of course, necessary to deal with them as well as with the uterus. It was formerly the custom of operators to remove both ovaries and tubes along with the diseased uterus, but at the present time practically all surgeons are agreed that at least one ovary or a part of one ovary should be left behind. The object of so doing is to avoid the unpleasant symptoms due to an artificial menopause. Unless the section

through the uterus has passed above the level of the internal os, and so has left a residuum of corporeal mucosa, menstruation will of course never be re-established, but the patient will be saved from hot flushes and other nervous symptoms.

Palliative Treatment of Fibroids.—There is no treatment except operation which will get rid of the fibroid. Apostoli's method of electrical treatment has long been abandoned as useless. The operation of castration is not much safer than hysterectomy, and is of very doubtful value. Hæmorrhage may be restrained for a time by curetting and the gauze pack in the case of a small submucous fibroid, and anæmia may be combated by iron and arsenic, while pain may be relieved by warm local applications and by opium.

Adenomyoma of the Uterus.—This form of uterine tumour has lately attracted considerable attention. In structure it resembles a myoma, but the muscle bundles are interspersed with numerous glands and spaces lined by glandular epithelium, closely approximating to the epithelium lining the uterine cavity and uterine glands, and in all probability derived from it, though some pathologists consider that the glands arise from remains of the Wolffian duct. The tumour differs from a fibroid macroscopically in that there is no distinct line of demarcation between it and the uterine muscle which bounds it. It may be more or less circumscribed, but in many cases it forms a layer underlying the uterine mucosa (diffuse adenomyoma), and causing a general, not a nodular, enlargement of the uterus.

The prominent **symptom** is hæmorrhage, and the **treatment** is hysterectomy.

MALIGNANT TUMOURS OF THE UTERUS.

Carcinoma—Pathology.—One of the most common seats of cancer in the human body is the **cervix uteri.** According to the portion of the cervix in which the growth has its origin, it conforms to one of two types. When arising from the **vaginal mucosa of the cervix,** the tumour is an ordinary **squamous epithelioma,** with cell nests and keratinization. Opportunities of observing the early stage of such a growth are rare, as the disease is usually well advanced before patients come under observation. It is very commonly first seen as a **"cauliflower" growth,** which may be of great size and may wholly obscure the outlines of the cervix. In other cases the tumour has undergone extensive necrosis, and has sloughed in the centre, leaving a **foul cavity.** There is a great tendency for the growth to spread to the vagina and to implicate the recto-vaginal and vesico-vaginal septa, with subsequent sloughing, and the formation of **fistulæ,** which may ultimately convert rectum, vagina, and bladder, into one common cloaca. Should the carcinomatous growth arise in the upper portion of the **cervical canal,** it conforms to the **adenocarcinomatous** type, and often produces great thickening of the cervix. Ultimately it also breaks down, leaving a ragged cavity with sloughing walls. The growth in either case tends to extend into the base of the broad ligaments, and the **ureters** may be surrounded and **compressed,** leading to hydronephrosis. It is remarkable that cervical growths only extend to the body of the uterus very late in the course of the disease. **Cancer of the cervix** is usually found in women who have borne children, and in some cases

it has been seen arising from an erosion or from cervical mucosa everted owing to cervical laceration (**ectropion**).

Cancer of the body, on the other hand, is more commonly seen in women who have not borne children, and is a much rarer form than cervical cancer. The growth is at first confined to the endometrium, where it appears in the form of whitish friable masses of cheesy consistence, sometimes flat and sessile, but more often lobulated or polypoid. Microscopically the tumour, which may arise either from the surface epithelium or from the glands of the uterine cavity, usually conforms to the type of an adenocarcinoma, but in rare cases assumes

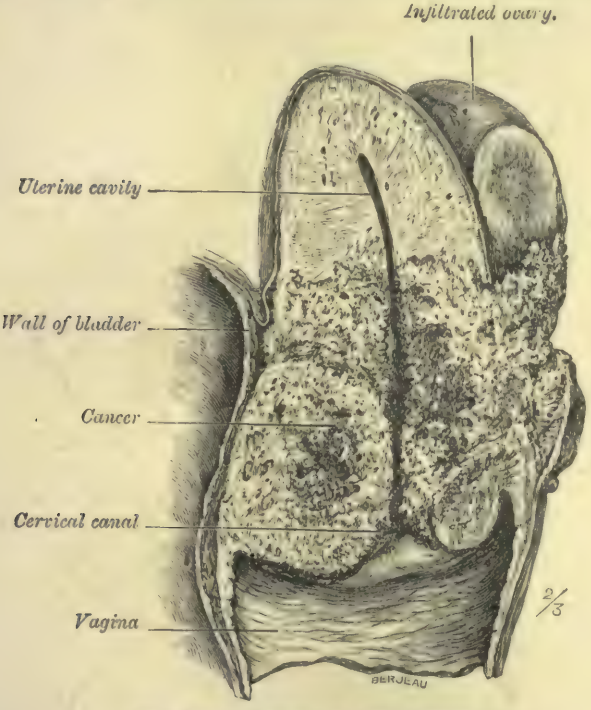

FIG. 135.—CANCER OF THE CERVIX UTERI.
(Bland-Sutton and Giles's "Diseases of Women.")

the more malignant type of solid masses of epithelial cells, and in some instances may even assume the type of a squamous epithelioma. As the tumour grows, it causes considerable increase in size of the uterus, and ultimately necrosis and breaking down of the older portions of the growth occur, with considerable enlargement of the uterine cavity, whose walls are then formed of necrotic cancer bathed in thin foul pus. The walls of the uterus are early infiltrated with the growth, which soon extends to the peritoneal surface, where it can be recognized in the form of flat yellowish nodules. More rarely it involves the cervix, and occasionally the tubes and round ligaments.

As regards **glandular infection,** cervical cancer is disseminated at an earlier stage than corporeal, the glands affected being first those in the parametrium, and then those lying along the external and internal iliac vessels. It is interesting to note that even where the glands are

macroscopically enlarged they are not in all cases cancerous. Distant organs are only affected late in the course of uterine cancer, and the liver is the most usual seat of metastasis.

Symptoms.—Until it has reached the stage of necrosis and ulceration, cancer of the uterus causes, unfortunately, few symptoms which might draw the attention of a healthy woman to her grave risk. The first note of warning is usually given by a **watery discharge,** often dirty or foul-smelling, or by **hæmorrhage,** either **spontaneous** or **provoked by douching, examination, or coitus.** This hæmorrhage is only too often regarded by the patient, and even by her medical adviser, as more or less physiological and due to the " change of life," and so valuable time is lost. The woman is encouraged by the absence of pain to regard her complaint as trivial, for pain, though it may be extreme in the later stages of the disease, is seldom present until the growth has extended so far as to involve the broad ligaments and infect the glands, causing pressure on the nerves within the pelvis. It cannot be too strongly impressed on the student that **every woman between thirty-five and fifty-five who complains of irregular hæmorrhages or of watery discharge should be at once examined with the finger and with the speculum.** Should nothing be felt or seen in the cervix, but should enlargement of the body of the uterus be made out, it is well to curette and to have the scrapings examined by a competent pathologist, so as to exclude corporeal cancer. The patient will the more readily submit to this when it is explained to her that, should there be no serious lesion present, the trifling operation will relieve her of her symptoms by removing the diseased mucosa which is causing the hæmorrhage.

On making a **vaginal examination,** the findings will vary with the stage which has been reached by the growth. Before breaking down and excavation have occurred, a cervical cancer presents itself most frequently as a **fungating " cauliflower " mass** springing from one or both lips of the cervix. Though distinctly harder than the normal cervical tissue, it has neither the " stony " hardness of scirrhus nor the " wooden " hardness of a fibroid, but is at once **firm and brittle,** so that the finger can be dug into the tumour, and will even break off pieces of it without much difficulty. **Bleeding follows examination** almost always. When the tumour has developed in the interior of the **cervix,** that part is **thickened and enlarged. Cervical cancer** must be diagnosed from a **fibroid of the cervix,** which is fibrous rather than granular in consistence, has a definitely circumscribed outline, and does not bleed quite so readily, even if it be sloughing. Sometimes an old **laceration of the cervix with** subsequent **fibrosis** is mistaken for cancer, but here again there is no abnormal brittleness, there is no tumour, and there is little tendency to bleeding on manipulation. In the later stages the cervix, and often the upper part of the vagina, are converted into a cavity whose walls are lined with sloughing growth and whose margins are formed of typical cancer masses.

In **cancer of the body** the uterus is felt to be enlarged, and may present irregular nodules. If invasion of the cervix has taken place, the canal will be dilated and its cavity lined with breaking-down growth. **Bleeding** often results **from merely manipulating the uterus.** Diagnosis has to be made from other enlargements of the uterus due to fibroid, fibroid polypus, endometritis, and chronic fibroid metritis, and in many cases only curettage will settle it. In cases of cancer the

curette brings away whitish or creamy masses, often of considerable size and of brittle consistence, instead of strips or tags of mucous membrane, and a microscopic examination will make their precise character clear.

Radical Treatment.—Although a **high amputation of the cervix** used to be practised for cervical cancer, this has been abandoned in favour of the complete removal of the uterus either by the vaginal or by the abdominal route. Of the two operations, **vaginal hysterectomy** has a much lower immediate mortality, and recovery is more rapid ; but, on the other hand, **abdominal hysterectomy** is feasible in cases where the total removal of the growth by the vaginal route would be impossible, and so far as statistics go the prospects of recurrence seem less. The cases recognized as suitable for **vaginal hysterectomy** are—(1) All cases of **cancer of the body** of the uterus, with no gross extensions of growth into the parametrium, and when the uterus has not reached such a size as to make it difficult to remove through the vagina ; (2) cases of **cervical cancer** in which the growth has not extended beyond the limits of the cervix either into the vaginal vault, into the base of the broad ligament, or into the bladder or rectum, and in which the uterus is freely movable and can be drawn down to the vulva. The **indications for abdominal hysterectomy** are not so clearly defined. Some surgeons operate on practically all cases unless the vagina is very extensively involved in the growth, or the pelvis is filled with secondary extensions of it. Most surgeons would, however, restrict the operation to cases which fulfil the indications given for vaginal hysterectomy, with the addition of those which have localized extensions to the vaginal vault, or which show circumscribed extensions into the base of the broad ligament though the uterus is still movable.

When the abdominal operation was first generally adopted in this country, it was considered specially suited to cases which were too far advanced for the vaginal operation. As surgeons become more familiar with the method and more expert in the use of it, it will probably take the place of the vaginal operation, as it offers greater security against infection of the cut vaginal surfaces with fragments of growth, and permits of a wider removal of the parametric tissue.

Vaginal Hysterectomy.—The **cancerous growth is first removed** as completely as possible **with a sharp curette** or spoon, and the raw surface is then **disinfected** with the actual cautery or with pure carbolic or formalin solution. The **lips of the cervix** are then **sutured** together with strands of thick silk, which are left long to serve as tractors. An incision is then made across the vagina just in front of the anterior lip of the cervix, and the **bladder is separated** from the anterior surface of the uterus, to which it is attached by loose connective tissue. This separation is effected by the finger aided by a gauze swab. When the **vesico-uterine fold** of peritoneum has been reached, it is **incised,** and two fingers are passed into the opening, which is torn so as to extend across the front of the uterus. A finger is now passed into the base of each broad ligament in turn, and the **base of the bladder** and the **ureters** are **freed** from their posterior connections and pushed well upwards. The cervix is next drawn forwards and the posterior fornix exposed. It is incised transversely ½ inch behind the cervix, and the **recto-uterine pouch** of peritoneum which presents in the incision is **opened.** Access is thus obtained to the posterior surfaces of the **broad ligaments,** which are **tied off** by

successive ligatures of strong silk passed from behind forwards by means of a large aneurism needle or a pedicle needle. Each ligature is placed as far outwards as possible, and the portion of broad ligament between it and the uterus is cut before the next ligature is inserted. As the ligatures are tied and the ligaments severed, the uterus is drawn downwards, and when the **last ligature,** which is **placed outside the ovary,** is tied, and the upper part of the ligaments severed, the uterus is free and is drawn out of the vagina. The stumps of the broad ligaments are drawn down, and fixed to the angles of the vaginal wound by suture. The wound itself may be sutured so as to close the peritoneal cavity, or, if there is any fear of sepsis, a gauze drain may be introduced into Douglas's pouch, to be removed at the end of a week. The silk ligatures separate in about two weeks.

Abdominal Hysterectomy.—This operation is usually associated with the name of Wertheim in this country. It had, however, been practised by other surgeons (Kelly, etc.) before the results which he brought before the profession in 1906 led to its general adoption.

The steps of the operation are as follows : The **growth** is **removed** as far as possible **with the curette,** and **disinfection of the vagina** is carried out either by a preliminary course of a week's antiseptic douching, or by cauterization with the actual cautery, or with a strong antiseptic, such as pure carbolic or formalin, at the time of the operation. The patient is put in the Trendelenburg position, and an **incision** made in the mid-line of the abdomen **from the pubes to the umbilicus.** The **intestines** are then lifted up out of the pelvis and pushed into the upper part of the abdomen, where they are **retained by packing** with large abdominal sponges, which also serve the purpose of preventing infective matter from finding its way into the general abdominal cavity. The uterus is now drawn forwards and upwards, and an **incision** made in the peritoneum of Douglas's pouch on either side **about an inch below and behind the ovary.** Through this incision the **ureter,** which may be recognized by its vermicular contractions, is **exposed,** and is **followed up** to the back of the broad ligament. The **ovarian** and **round ligaments** are now **tied** and divided, the uterus is then drawn backwards and the peritoneal reflection from the bladder on to the uterus is opened up, and the **bladder freed from the uterus and vagina.** The **terminal portions** of the **ureters,** where they enter the bladder, are **exposed,** and they are followed backwards to the broad ligament. The finger is now passed through the loose tissue of the broad ligament along the course of the ureter, and a **ligature** is passed by its side, which **controls the uterine artery.** This is tied and the ligament and artery cut. The upper half of the **vagina** is now **freed** from its attachments, and is **clamped across** by Wertheim's rectangular clamps well below the cervix. The **vagina** is then **cut across** below the clamps, and the uterus and upper half of the vagina are removed. Any bleeding-points are picked up and tied, the cut edges of the vagina are whipped with catgut, and a loose pack of gauze is placed in the bottom of the pelvis. The peritoneum is brought together over this pack as neatly as possible, and the abdomen closed. The pack is removed at the end of a week or ten days.

The **dangers of the operation** are—**shock,** which is met by rapidity of operating as far as is consistent with safety, and by saline solution *per rectum* afterwards ; **hæmorrhage,** which may be controlled, when excessive, by ligature of the internal iliac artery or of its anterior division ; and **sepsis,** which is obviated by thorough preliminary dis-

infection of the cervix, and by the use of the clamps on the vagina, to prevent leakage of infective material from the uterus while it is being drawn out of the abdomen. As practised by some operators, abdominal hysterectomy includes, where need requires, the clearing out of enlarged glands from the neighbourhood of the iliac vessels, and resection of the rectum or of the base of the bladder should these organs be involved in the growth.

Abdomino-Vaginal Hysterectomy.—In this method, which is not in very general use, the abdomen is first opened, and the broad ligaments and ovarian and uterine vessels are secured and divided as close to the pelvic wall as possible. The abdomen is then closed, and the separation of the uterus from the vagina is effected from the vagina, through which the uterus is drawn out to avoid any possibility of soiling the peritoneum.

Treatment of Inoperable Cancer.—To control hæmorrhage and foul discharge, **antiseptic douches** should be used. In most cases benefit results from a thorough **curetting of the growth,** followed by the application of the actual cautery or of a strong cauterizing agent, such as chloride of zinc (50 per cent. solution), acetone, or formalin. A slough is formed, which separates, and cicatrization takes place, checking materially the local spread of the disease. There is a risk that the bladder or rectum may be involved in the slough, and a fistula result. For the pain morphia is given. Recently a large amount of work has been done in treating these cases with X-rays or radium emanations, and the results so far have been distinctly encouraging, though it is probably too much to hope that anything more than temporary benefit can be looked for from the use of the method.

Sarcoma of the Uterus.—This form of malignant growth is much less common than carcinoma. It attacks the body more frequently than the cervix, and may be either of the **round** or **spindle celled** type. A true **giant-celled sarcoma** of the uterus occurs. A peculiar form—the **grape-like sarcoma of the cervix**—is occasionally seen. The growth takes the form of rounded dropsical masses, which depend from the cervix and somewhat resemble the vesicles of a hydatid mole.

Symptoms.—The chief symptom is **hæmorrhage.** On examination the uterus is enlarged, and microscopic examination of the curetted fragments will reveal the nature of the growth.

Treatment.—Complete **hysterectomy** alone affords a prospect of cure. Remote secondary growth is late in its occurrence, but recurrence in the vaginal scar is only too common. Should the disease be too far advanced for a radical operation, an attempt should be made to control hæmorrhage and discharge by curetting and cauterization.

Chorionepithelioma (Deciduoma Malignum).—This form of tumour was first described by Sänger in 1892, and is probably not so rare as was at first supposed. Most of the reported cases have followed a **hydatid mole,** but almost an equal number have been reported as sequelæ to **abortions** and to **premature** or **full-term deliveries.** The tumour takes the form of masses, which from the amount of extravasated blood present in them might almost be mistaken for masses of blood-clot. On microscopic examination, syncytial masses of protoplasm with numerous nuclei are to be seen, and in close connection with these are numerous large cells with large rounded nuclei. These two distinct elements of the tumour by their appearance and staining

reactions recall the syncytial and Langhans' layers of the fœtal envelopes from which the tumour is supposed to arise. Early metastases are the rule, and are seen in the vagina, lungs, and abdominal organs. The malignancy of the tumour is very variable. Sometimes it rapidly causes death by extensive metastatic deposits; at other times a mere curetting suffices to effect a cure. Two curious facts have been noted in connection with this form of tumour: After removal of the primary growth, the metastases have been known to disappear; and, secondly, the tumour is not confined to the female, since it has been observed as a tumour of the testis.

Symptoms.—Irregular hæmorrhages occurring after an abortion or after the expulsion of a hydatid mole should lead to a curetting and examination of the fragments, when the diagnosis is made by the characteristic microscopic appearances.

Treatment.—Hysterectomy.

NEW GROWTHS OF THE TUBE.

Cancer, fibromyoma, and sarcoma, of the tube have been described, but they are extremely rare and have little practical interest.

TUMOURS OF THE OVARY.

Pathology.—In the ovary and its accessories, the following parts are distinguished, each containing structures which may give rise to cysts:

1. **Oöphoron.**—The free portion of the ovary, **covered by germinal epithelium,** not by peritoneum, and containing the **Graafian follicles.**

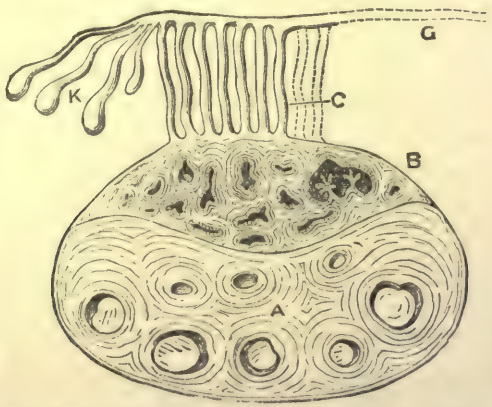

Fig. 136.—Schematic Representation of Ovary.
A, Oöphoron; *B*, paroöphoron; *C*, parovarium; *G*, Gärtner's duct.
(Bland-Sutton and Giles's "Diseases of Women.")

These structures are developed from downgrowths of the germina epithelium, and consist of a sac filled with serous fluid and lined by a layer of cells (stratum granulosum), from which a small mass of cells (discus proligerus), with the ovum in its centre, projects into the cavity. As the ovum ripens and the follicle matures, it sinks deeper

into the substance of the oöphoron; but when fully matured it again approaches the surface, owing to distension with fluid, and eventually ruptures about the time of a menstrual epoch. The cavity left in the ovary is filled by a reddish jelly-like mass of lutein cells derived from the stratum granulosum, and enclosing a central cavity. These in time become organized, and are replaced by a depressed scar.

2. **Paroöphoron.**—The fibrous hilum or attached portion of the ovary, **covered by peritoneum,** and containing **glandular tissue,** the remains of the Wolffian body.

3. **Parovarium (Organ of Rosenmüller).**—A tubular structure lying between the layers of the mesosalpinx. The tubes run at one end towards the paroöphoron, and at the other join a longitudinal tube running towards the uterus (**Gärtner's duct**).

Ovarian Cysts—1. **Graafian Follicle, or Follicular Cysts.**—A normal mature follicle may reach the size of a pea before rupturing, and it is difficult to say at what point we are to consider an unruptured follicle as a pathological cyst. There can, however, be little doubt that, when we find the ovary converted into a mass of cysts ranging in size from a pea to a marble, we are dealing with a pathological product. The cysts in such a **polycystic ovary** are translucent or semitranslucent, may be lined by a layer of flattened epithelium, and contain clear serous fluid. More important, perhaps, is the **solitary cyst,** which may attain the size of a fœtal head, or even larger. Its wall is in the main thin and translucent, but near its attached base or pedicle the wall is thickened by the spreading out of the ovary over its surface. It is lined—in part at least—by flattened epithelium, and contains clear serous fluid.

2. **Lutein Cysts.**—These cysts are of small size, seldom exceeding that of a walnut. They are thin-walled, and are of a brownish or bluish colour. The contents consist of a fibrinous clot and of serum or altered blood. A layer of bright yellow lutein cells is conspicuous in the wall. Calcification of the clot may occur, leading to the formation of an ovarian stone.

3. **Ovarian Dermoids.**—These tumours are fairly common, and are found in patients both old and young, though they are never congenital. They are usually of moderate size, seldom exceeding that of the adult head. Properly speaking, an ovarian dermoid is an **embryoma,** as it contains representatives of all the layers of the embryo. The tumour is made up of a **cyst** and of an **embryonic rudiment.** The **cyst wall** is fibrous, and is lined by stratified epithelium. Its **contents** consist of a mass of sebaceous matter, containing cholesterin, and usually mixed with shed hair, which is often rolled into balls. The **embryonic rudiment** varies enormously in development. In its simplest form it consists of a nipple-like process projecting into the cyst, and crowned by a tuft of hair. In the more elaborated forms teeth are frequently developed, usually embedded in bony plates, and in the most complex there may be found mixed in confusion structurally perfect glands of every description, pieces of fully-formed intestine, and masses closely resembling brain substance. In rare instances cancer may arise in the epithelial structures of a dermoid, or the tumour may itself show malignant characters, metastases consisting of small masses of tissue, with hair growing from them, being developed on the peritoneum as high as the liver.

There are two theories of the origin of these tumours. According to the one, the tumour represents an attempt at **parthenogenetic**

development of an ovum. According to the other, the tumour is an **included twin** fœtus.

4. **Multilocular Ovarian Cyst (Proliferating Ovarian Cyst, Adenoma of the Ovary).**—This is the most common form of ovarian tumour. It is not found before the age of puberty, but may develop at any age afterwards. If left to grow, it may reach an enormous size before causing the death of the patient. The **exterior** of the cyst is smooth, shining, and white or bluish-white in colour. It is usually more or less lobulated, the outward expression of a division into daughter cysts. The **wall** is fibrous, and is lined by a layer of columnar cells, rarely ciliated, which in the larger cysts have often become flattened

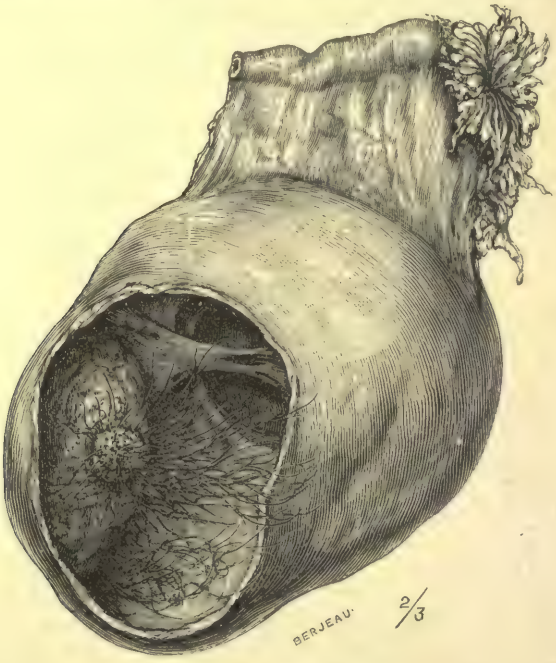

FIG. 137.—OVARIAN DERMOID.
(Bland-Sutton and Giles's "Diseases of Women.")

by pressure. A common arrangement is that of one or more large cysts with knob-like projections into their interior. These knobs consist of innumerable small daughter cysts, often so closely packed as to give the impression of a solid mass. The **contained fluid** may be clear, yellowish, brown, or greenish, and whitish opaque streaks of degenerated epithelial cells may usually be seen in it. The consistence varies from a thin and watery fluid to that of a tough jelly, practically semisolid, and depends on the amount of **pseudo-mucin** present, secreted from the epithelial cells. Not uncommonly dermoid elements are associated with these tumours.

5. **Papillary Ovarian Cyst (Proliferating Papillary Cyst).**—These cysts are seldom of large size. They are multilocular, and the cavities have their walls beset with papillæ. The contents are **serous**, and not **mucinous,** in character. The papillæ not uncommonly break through

the cyst wall, and grow into the abdominal cavity. When this has occurred, metastatic papillæ grow on the peritoneum, and ascites results. In a variety of this form of tumour, the papillary outgrowths mask the cyst formation, and the ovary takes the form of a tumour covered with cauliflower masses (**papilloma of the ovary**).

Solid Tumours of the Ovary.—Much rarer than cysts. The principal are—(1) **Fibroid,** a dense hard tumour, whitish in colour, irregular of surface, seldom exceeding the size of the closed fist, and composed microscopically of white fibrous tissue; (2) **cancer of the ovary,** which may be either glandular or papillary, the latter form having a close macroscopic resemblance to a papillary cyst. Recently Bland-Sutton has advanced the view that all solid cancers of the ovary are really secondary to growths elsewhere, the tumour cells which have reached the peritoneal cavity by way of the lymphatics sinking through force of gravity to the pelvis, where they become grafted on the surface of the ovaries. **Sarcoma of the ovary** is also found, but is very rare.

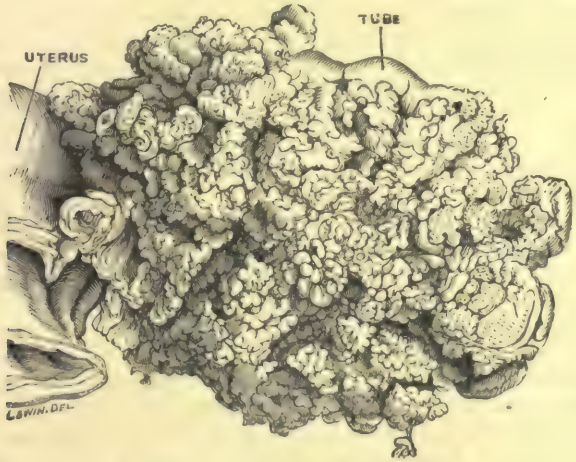

FIG. 138.—PAPILLOMA OF OVARY.
(Bland-Sutton and Giles's "Diseases of Women.")

Parovarian Cysts.—These cysts are developed from the parovarium, and consequently lie between the layers of the broad ligament and are covered with peritoneum. They are very thin-walled, monolocular, seldom of large size, and have the tube stretched out over their surface. The contents are of clear watery consistence, and the cyst is lined by ciliated epithelium.

Complications of Ovarian Cysts.—Of these, the more important are—1. **Torsion of the pedicle,** giving rise to strangulation of the cyst. The essential factor in this condition is rotation of the ovarian tumour, presumably caused by an impulse communicated by the intestinal movements. This rotation is predisposed to by a lax abdominal wall—*e.g.*, in a woman after delivery—and the result is to twist the pedicle or base of attachment of the tumour, which may exhibit as many as twelve turns, and so to interfere with the blood-supply of the tumour. The venous return is first obstructed, causing **hæmorrhage into the cyst wall,** which assumes a characteristic purple colour, and **into the cysts,** causing the contents to become brown, black, or grumous.

Rapid **increase in size** of the tumour occurs. In the most severe cases the blood-supply is completely stopped, or the pedicle may even be twisted off. **Inflammatory** change always supervenes, causing **adhesions** between the surface of the tumour and the neighbouring organs. Torsion of the pedicle gives rise to acute abdominal symptoms—pain, vomiting, and rigidity—and may be confounded with acute appendicitis, acute obstruction, or rupture of a viscus. The diagnosis is made by the discovery of a tumour giving the physical signs of an ovarian.

2. **Inflammation of the surface** of an ovarian tumour is a common complication, and may be suspected when the patient complains of attacks of pain over the region of the tumour, lasting for some time and associated with tenderness on pressure over the tumour. It derives its chief interest to the surgeon from the fact that it results in the formation of **adhesions** to the neighbouring organs, which may cause trouble in the operation of ovariotomy.

3. **Suppuration of the cyst** may occur, and the pus formed may discharge through the bowel, bladder, vagina, or even through the abdominal wall. Dermoids are specially prone to suppurate.

4. **Rupture of the cyst** is not a common accident. It occurs in thin-walled cysts—*e.g.*, parovarian cysts—and is caused by external violence or sudden violent movement. There is an immediate diminution in the size of the cyst, with signs of free fluid in the peritoneal cavity, Profuse diuresis follows. The rupture in the cyst wall heals, and the fluid reaccumulates.

Symptoms and Diagnosis of Ovarian Tumours.—The symptoms directly referable to an ovarian tumour as such are insignificant, and a patient's first warning of the presence of a large cyst may be the increase in size of the abdomen caused by its bulk. The symptoms not infrequently complained of are due either to the pressure of the tumour on neighbouring organs, or to the onset of such complications as inflammation, rupture or torsion of the tumour.

An **intrapelvic** tumour is often accompanied by a sensation of weight and fulness in the pelvis. **Pain** is often complained of, referred to the affected side, radiating to the back and down the thighs. It is very frequently present in the case of a follicular, lutein, or dermoid, cyst. There may be pain on defæcation, or frequency of micturition.

An **intrapelvic tumour** cannot be diagnosed by abdominal signs. **Tenderness on palpation** over the ovarian spot at the outer border of the rectus, and about 2 inches above Poupart's ligament, may be present, and **ascites** usually accompanies a fibroma or a papilliferous cyst. On **vaginal examination** the ovary is felt as a rounded or ovoid tumour. It rarely occupies its normal position. As a rule, owing to its increased weight, the tumour slips down towards the bottom of the pelvis (**prolapse of the ovary**), and lies more or less behind the uterus. Usually the tumour is movable, and is separable from the uterus. It may, however, become fixed by adhesions. This may be regarded as the rule in the case of dermoids and malignant growths. Tenderness on pressure is usual. An intrapelvic ovarian tumour is distinguished from a **pyosalpinx** or **pregnant tube** by its shape, situation, and mobility. It is difficult or impossible to distinguish an ovarian tumour adherent to the corpus uteri from a subserous uterine fibroid. The tyro may mistake the **fundus** of a **retroflexed retroverted uterus** for a prolapsed ovary.

If the **tumour has risen into the abdomen,** pressure symptoms are

usually absent until a late stage, when embarrassment of respiration and interference with the circulation of the lower half of the body are caused by the pressure of the tumour mass on the thorax and inferior vena cava. Owing to the situation and fixity of the growth, an **intraligamentary cyst** causes early and persistent pain from pressure. **Menstruation** may be unaffected. Where the tumour is inflamed—*e.g.*, dermoid—or when pressure has caused uterine congestion, the flow may be increased. It is often lessened in the case of a large multilocular cyst.

When an **ovarian tumour** has risen **into the abdomen,** it may at first incline to one side; later it invariably occupies the middle line. It causes a protuberance of the abdomen, which is most marked between the umbilicus and the pubes, and when the patient is lying on her back the abdominal contour has a marked conical outline, in sharp distinction to the flattened contour of **ascites.** On **palpation,** the tumour may be felt to have a **lobulated surface,** or may be **smooth. Fluctuation** can usually be elicited in a cyst, but its distinctness varies with the consistency of the contents and the number of loculi. On **percussion,** the tumour area in the centre of the abdomen is dull down to the pubes, while resonance is obtained in the flanks and along the upper margin of the tumour. **Auscultation** may reveal the presence of a bruit. On **vaginal examination,** the tumour is often felt to rest on the brim of the pelvis, but occasionally descends into it. The uterus can be made out, usually in retroversion, below the tumour, and distinct from it.

Almost any tumour in the abdomen may be confounded with an ovarian cyst. In practice it is important to distinguish it from (1) a **pregnant uterus** by the absence of alternate contractions and relaxations (Braxton Hicks's sign), by failure to distinguish fœtal parts or the fœtal heart, by the absence of concomitant signs of pregnancy, and by separating the uterus from the tumour on vaginal examination. It is also important to diagnose tumour from (2) **ascites,** which is done by observing the contour of the abdomen—flattened in ascites, conical in tumour—by noting the characteristic area of dulness and the variation in the dulness caused by alteration of position in ascites. It should be noted that ascites sometimes coexists with tumour, and that a circumscribed tuberculous ascites may give physical signs practically identical with those of ovarian cyst. (3) A **uterine fibroid,** if pedunculated and cystic, may be indistinguishable from a cyst. Usually vaginal examination and the fact that the tumour is separate from the uterus will make the diagnosis clear.

Treatment of Ovarian Tumours.—The symptoms caused by a **small follicular or lutein cyst** may be relieved for a time by measures adapted to reduce pelvic congestion, such as the tampon and douche. It may be safely asserted, however, that, when an ovarian tumour has reached the size of a hen's egg, permanent relief will only be afforded by the removal of the tumour. In days not long distant an enlarged ovary was always removed *in toto* (**oöphorectomy**). Nowadays, whenever it is possible, the free part of the ovary, with its contained cysts, is alone removed, and the portion of ovary abutting on the hilum is left (**resection of the ovary**), thus preserving to the patient enough of the gland to furnish an internal secretion and to obviate the danger of an artificial menopause should the other ovary require removal. A large cyst of the ovary entails removal of the entire organ with the cyst (**ovariotomy**).

Operative treatment may be undertaken either by the **abdominal** or **vaginal** routes. The **abdominal route** has the advantage that it requires less technical and manipulative skill, and is therefore more easy of performance to the average operator. It affords a clear view of the pelvic organs, and permits of adhesions being dealt with under the guidance of the eye. The aperture in the abdominal wall can be enlarged to allow of the extraction of a tumour of any size whole and unbroken, and there is better opportunity for the performance of an appendicectomy, suture or anastomosis of intestine, should such a proceeding become necessary. On the other hand, the **vaginal route** entails a less tedious recovery, there is no risk of hernia through the scar, the incision is ideally placed for drainage if required, and there is the minimum of disturbance to the abdominal contents. The vaginal route is suitable where there is a wide or dilatable vagina and a tumour not larger than a fœtal head. The abdominal route is better when the vagina is narrow or rigid, the tumour a large one, or if complications or adhesions are present.

Abdominal Method.—The incision is usually made through the linea alba, between the umbilicus and the pubes. Some operators prefer to go through the rectus muscle an inch to one or other side of the middle line. The **Pfannenstiel incision** is used more extensively on the Continent than in this country. A transverse cut through skin and rectal sheath is made from one iliac spine to the opposite one ; these structures are raised as flaps upwards and downwards, and the recti and peritoneum are then divided vertically. This incision gives greater security against subsequent hernia, but is not suitable for the removal of large tumours.

When the abdominal cavity is opened, the tumour, if a large one, usually presents in the wound ; if it be a small one, the hand is introduced into the pelvis, and the tumour is sought for and delivered through the abdominal opening. The operator then decides whether the whole ovary must be sacrificed or whether a portion can be saved.

If the whole ovary is to be removed (**oöphorectomy**), the pedicle by which it is attached, and which consists of the mesovarium with the tube and mesosalpinx, is transfixed by a pedicle needle armed with a double ligature, care being taken to avoid piercing any large veins. The loop of the ligature is caught and divided. Each half of the ligature is then tied separately on the two portions of the pedicle in such a way that the loops of the ligatures interlock. The ovary is then removed by cutting across the pedicle on the distal side of the ligatures, leaving a good button of tissue above them to prevent slipping. It is advisable to tie the ovarian artery separately in the stump, and to cover the raw surface as well as possible by drawing up the peritoneum with a purse-string suture. Many operators prefer to secure the vessels by a continuous suture, which takes up the ovarian artery in its first bite, closes the cut in the broad ligament, and is finally tied around the stump of the utero-ovarian ligament.

Should **resection of the ovary** be decided upon, the oöphoron with its contained cysts is removed by a wedge-shaped incision, leaving the hilum of the ovary and the part of the gland adjacent. Hæmorrhage is checked and the flaps of ovary united by a continuous suture.

The technique of an **ovariotomy** differs in no material detail from that of an **oöphorectomy.** When the abdominal incision has been made, and the diagnosis confirmed by the characteristic pearly-white appearance of the presenting cyst, the incision should be rapidly en-

larged with scissors until the tumour can be delivered entire, when its pedicle is dealt with in one of the ways already indicated and the cyst removed. In the classical method of operating, still followed by a decreasing number of surgeons, a small abdominal incision is made; the volume of the cyst is then reduced by tapping, and the tumour, thus lessened in bulk by the evacuation of its fluid content, is delivered through the abdominal incision for removal. The objection to this method is that it is impossible to tell before opening the cyst whether malignant degeneration has not occurred, and, as it is practically inevitable that some of the contents will reach the peritoneal cavity during the process of tapping, the method may result in the dissemination of a malignant tumour during the very process of its removal.

Complications of Ovariotomy.—While an uncomplicated ovariotomy is perhaps the simplest of all major operations, the presence of adhesions between the cyst and the surrounding organs often causes much trouble to the operator, and may tax his skill and resource to the utmost. Recent adhesions may be separated by the hand or by wiping them off with a gauze swab. Older adhesions, if elongated, may be ligatured and divided; if short, they must be dissected off the cyst wall, and the bleeding-points secured afterwards by ligature or suture. Raw areas may thus be left on the intestines, which will require covering either with omentum or by infolding. When suppuration of the cyst has taken place, the adhesions are very dense, and suture of intestine may be necessary on account of an opening either already existing or caused accidentally in the process of separation. This accident is best avoided by carrying the dissection through the outer fibrous layer of the cyst wall, which is left attached to the intestine. In the worst cases, where the cyst is universally adherent to the whole of the structures in the pelvis, it may be necessary to leave a portion of it behind after evacuating the contents and destroying its lining membrane with the cautery, drainage being provided through the abdominal wound or through an opening in the vagina.

Removal of Intraligamentary Cysts.—The method described above is inapplicable for these tumours, as they are covered by peritoneum and have no true pedicle. When the cyst is small, it may be enucleated after ligature of the ovarian artery on the same side. If it is large and burrows deeply by the side of the uterus, a more extended operation is necessary. The ovarian artery on the tumour side is first ligated; the operator then ligates the ovarian on the sound side, cuts down through the broad ligament, ties the uterine, and cuts through the cervix, exactly as in a Kelly's hysterectomy. The uterine on the tumour side is then tied and the uterus pulled upwards, when the tumour can be enucleated from below with ease, and without hæmorrhage, as all the arteries are secured.

Vaginal Cœliotomy for Ovarian Tumours.—An ovary affected with tumour or disease may be attacked from the vagina either through the anterior or posterior fornix. The initial steps of a posterior colpotomy are simpler and easier to carry out than are those of an anterior colpotomy, and the opening is better placed for drainage if it be required; but a much better exposure of the affected organ is gained through the anterior incision, and it is much easier to deal with the pedicle.

Posterior Colpotomy.—A transverse incison is made through the posterior vaginal wall just below its junction with the cervix, which

is drawn upwards by volsella. The peritoneum presents in the wound, and is picked up with forceps and divided, access being thus given to the pouch of Douglas. Two fingers are then introduced into the opening, which is torn laterally to the full width of the vagina. The ovary is then sought for and delivered through the wound, and, according to its condition, may be either resected or removed according to the technique already described in connection with the abdominal operation. The operation is completed by suturing the rent in the peritoneum and in the vaginal wall, an opening for drainage being left if necessary.

Anterior Colpotomy.—An incision is made through the anterior vaginal wall at its junction with the cervix; the bladder is then stripped off the anterior aspect of the cervix until the utero-vesical pouch of peritoneum has been reached. This pouch is then opened, and the opening extended laterally to the full width of the uterus. The anterior wall of the uterus is drawn into the wound with volsella or sutures passed through it and left long for traction, until finally the fundus is brought into and through the vaginal incision. By dragging on the fundus the ovaries are brought into view, and may be delivered into the wound and dealt with as may be necessary. Additional room may be obtained by extending the vaginal incision on to both sides of the vagina in a horseshoe fashion (Strassman), and quite large tumours may be removed by this route, especially if their bulk be first reduced by tapping.

DISEASES OF THE FEMALE URETHRA AND BLADDER.

Stricture of the Female Urethra is very rarely met with. It usually follows injury, and is easily treated by dilatation.

Urethral Caruncle.—In women of middle life and over it is not uncommon to find at the orifice of the urethra a small sessile growth of a cherry-red colour. This growth, which recalls a nævus in structure, is rarely larger than a split pea, but may exceptionally reach the size of a small cherry. It sometimes gives rise to no inconvenience, but in most cases it causes great vesical irritation, evidenced by frequent and painful micturition.

The only effective treatment is to remove the little growth, which may either be dissected out or be destroyed by the actual cautery.

Urethral Polyp.—This is a rare form of growth, springing as a rule from the external urinary meatus. It should be twisted off, and the base cauterized to prevent recurrence.

Cystitis.—Acute Cystitis is a common complaint in the female. It s predisposed to in multiparæ. This is readily explained when we recollect the comparative shortness of the urethral canal in the sex, and the fact that in multiparæ the urinary meatus stands widely open, and is exposed by the gaping of the vulva to trauma and infection from the underclothing; while the frequent presence of cystocele creates a mechanical obstacle to the complete emptying of the bladder, and favours the formation of a pouch containing residual urine. When we add that, with so many factors favouring the introduction of infection, the urethral orifice is not uncommonly bathed constantly in a septic leucorrhœal discharge, we shall be inclined to wonder that cystitis is not even commoner than it is. Many cases arise, unfortunately, through neglect of proper precautions in the passage of the

catheter after confinement or operation, although after a complete hysterectomy the most careful nursing may sometimes fail to avert cystitis, owing to the extensive interference with the supports of the base of the bladder and the injury to its muscular coat, vessels, and nerves.

The **Symptoms** of the affection are a sensation of pain and burning in the bladder, frequency of micturition, and pain at the completion of the act. The urine contains pus cells, often embedded in shreds of lymph, and in the severest cases blood. The infection if left untreated tends to become chronic, with some frequency of micturition and uneasiness, the symptoms showing exacerbations from time to time. Besides the common catarrhal form, ulcerative and even phlegmonous forms are described.

Treatment.—Many cases recover with confinement to bed, demulcent drinks, and the oral administration of a urinary antiseptic, such as urotropin or boracic acid. If the infection proves obstinate, washing out the bladder should be resorted to. For this purpose saturated solution of boracic acid, 1 in 10,000 corrosive sublimate, or ½ per cent. formalin, may be used. Inveterate cases require for their cure drainage of the bladder, which is secured by an incision through the vesico-vaginal septum into the base of the bladder. This incision has a great tendency to close up spontaneously; if it does not, it may be closed by a plastic operation when the cystitis is relieved.

Stone in the Bladder.—This complaint is not common in women, probably because the short and easily dilatable urethra permits of the passage of small particles of gravel which might serve as a nucleus for the formation of a vesical calculus. When a stone does form, it usually has as a nucleus a foreign body, such as a piece of broken catheter, a piece of silk which has worked its way into the bladder from the stump of a hysterectomy, or the like. The symptoms are similar to those found in the male, and the diagnosis is made by feeling the stone *per vaginam* and by sounding with a metal sound. Treatment by crushing and washing out the fragments is easy and satisfactory, or lithotomy through the vesico-vaginal septum may be performed, with subsequent suture of the fistula thus made.

Vesical Polypi or **Villous Growths** may be easily dealt with through an incision in the vesico-vaginal septum. **Cancer of the Bladder,** if discovered in its early stages, may be treated by resection.

Affections of the Kidney.—These do not differ from those found in the male, and have been dealt with in the previous chapter.

CHAPTER XXXIII

VENEREAL DISEASES: SYPHILIS—GONORRHŒA

SYPHILIS.—Historical and geographical note—*Spirochæta pallida*—Primary symptoms: Hard and soft chancres—Secondary symptoms: Contagion, skin eruptions affections of the eye, affections of the mucous membranes, affections of bones and joints, febrile conditions—Intermediate symptoms: Affections of skin, testicles, eyes, arteries, viscera, and nervous system—Tertiary symptoms: Distinctive features, contagion, gummata, periostitis, nodes, affections of the skin, tongue, and nervous tissue, tissue degenerations—Treatment of syphilis in general: Details of treatment—Congenital syphilis: Laws of inheritance, evolution of hereditary syphilis, symptoms, diagnosis, treatment of infantile syphilis, prognosis—Summary—Recent methods of diagnosis and treatment: Laboratory methods of diagnosis, demonstration of organism, complement deviation, Wassermann's reaction—Treatment of syphilis by Salvarsan: Methods of administration of the drug, method of preparation, administration, contra-indications, dangers, dosage, effects on the lesions.

GONORRHŒA.—The gonococcus: Demonstration—Pathology—Symptoms—Incubation period—Acute stage—Chronic stage—Gleet—Diagnosis: Two-glass test—Treatment, general management, administration of drugs, urethral medication, Bier's hyperæmic method, summary—Complications of gonorrhœa: Their diagnosis and treatment.

SYPHILIS and gonorrhœa are infective disorders of microbic origin and are not local diseases. They are nevertheless treated of in this position, immediately after the chapter on genito-urinary disorders and not under infections, because the manifestations of the diseases are, in the great majority of cases, met with in the genito-urinary organs in the first instance, and where properly treated are usually confined to those organs.

SYPHILIS.

HISTORICAL AND GEOGRAPHICAL NOTE.

The origin of the disease is shrouded in obscurity.

A great and virulent epidemic of syphilis swept over Europe in 1495. It is said to have been introduced into Europe in 1493, on the return of Columbus from his first voyage of discovery, by the men who accompanied him, and who became infected at Haiti. A violent type of the disease raged during the Siege of Naples, and this is also credited to the men of Columbus's command who had been drafted there; but as the town was not captured, by the Spaniards, till 1503, ten years after the return of the expedition to Europe, it is not likely that these men were directly concerned with the Neapolitan outbreak.

In all probability, it was not a new disease, but only noted on account of its great virulence.

Some again, attribute its introduction to the returning Crusaders; though perhaps aggravated by a fresh outbreak, it probably existed in Europe prior to the date of their return.

All countries are prone to the disease with the exception of Iceland. Climate seems to have much less to say to its severity than the social conditions under which the people of the country live. On the whole, the disease is milder in temperate climates than in an extreme of either heat or cold.

Syphilis is an infective disease, caused by a micro-organism, the *Spirochæta pallida*, producing local and constitutional symptoms.

The organism was discovered by Schaudinn in 1905 in syphilitic lesions, and is now almost universally recognized as the specific infecting agent in the disease. The organism has not been cultivated, but by means of material containing it and no other organism the disease has been conveyed to apes. It is uncertain whether it belongs to the animal or vegetable world. According to some observers, multiplication takes place by longitudinal division; according to others, by transverse division.

For demonstration and illustration of the *Spirochæta pallida*, see pp. 752-753.

Syphilis bears some resemblance to the infective fevers, in that it has an incubation period, and a certain amount of immunity is conferred by one attack. It differs materially from them in having tertiary manifestations.

The disease is peculiar to the human family, but can be inoculated into the higher anthropoid apes.

The general **Pathology** of syphilis is an infiltration of the connective tissues around the vessels by a large number of small round cells. A microscopic section of a chancre shows it to consist of granulation tissue; it is the large number of the small cells present which chiefly accounts for the hardness of the chancre.

Local or Primary Symptoms.

After a period of about five weeks from the time of infection, the true **hard chancre** makes its appearance.

A red spot, which itches, first forms; it extends day by day, and soon becomes a **papule.** At the end of seven to ten days a small indurated disc is formed; there is little surrounding inflammation, and no secretion from the surface of the ulcer.

The hardness of the Hunterian chancre is due to cell infiltration, unaccompanied by any giving way of cellular tissue. It is usually single, and disappears, even without treatment, in a variable time.

No new ulcers are produced subsequent to the full development of the first one, nor can others be produced by inoculation.

Simultaneously with the development of local induration hardening of the nearest lymphatics occurs; these are indurated like the chancres, and thus differ from the lymphangitis which follows soft chancre, in which the glands are soft like the sore—therefore, like chancre, like bubo. To the very hard variety the term "bullet bubo" has been applied.

The **Soft or Non-Infecting Chancre or Chancroid** arises from implantation of inflammatory infection. The true virus is seldom present, but if a mixed infection has taken place, the soft chancre may become a true hard one at the end of five weeks. It may be multiple. Inoculation on another part of the body takes effect.

The chancroid is an ulcer with abrupt margins, punched-out edges, grey unhealthy surface, and much surrounding inflammation. The non-indurated sore is scarcely ever seen, except on the genitals, because the vitality of pus elements is lower than that of the true virus.

The lymphatic glands swell and suppurate, and are glued together.

A patient may suffer from this local condition without constitutional or secondary symptoms, but, Hutchinson thinks, rarely, and that these sores usually, though soft, are infecting. That is, he believes that generally, though not always, there is a mixed infection, and that in some cases, after the expiration of several weeks, the soft or non-infecting sore becomes a hard infecting one, but that in other cases the sore may **remain soft, and yet be infecting;** and for this reason Hutchinson prefers the terms "infecting" and "non-infecting" to "hard" and "soft."

Variety of Chancres.—1. **True Hunterian, or Hard Chancre,** with marked induration.

2. **Soft Chancre,** becoming hard at the end of five weeks, probably due to two poisons being deposited at the same time—(*a*) an inflammatory, and (*b*) the true virus.

3. **The Desquamating Papule,** which is of a deep colour and very irritable. If irritated, it may develop into a Hunterian chancre, but without much induration.

4. **Parchment Chancre** is a true Hunterian; situated where the tissues are tense, as on the *glans penis*, there is a thin plate of induration, which is little raised above the surface.

5. **Soft Chancre,** a non-infecting inflammatory venereal sore, caused by Ducrez's streptobacillus. As stated above, it may sometimes be followed by the true infecting sore.

Usual Position of Chancres.—Hard: On the roll of the prepuce, just behind the corona, next in order on the frenum, meatus, and free border of the prepuce.

Soft: May appear almost anywhere about the genitals.

In the Female: (1) Labia; (2) fourchette; (3) clitoris, never in the vagina itself, because of (*a*) the infrequency of gland orifices, (*b*) thickness of the epithelium; (4) os uteri—it is seldom seen in this latter position.

It must be remembered, however, that syphilis **is not necessarily a venereal disease,** and that a hard chancre may be met with in many positions; a common place is on the lips, produced usually by a pipe or a kiss. The tip of the finger is another fairly common site, especially among medical men, being usually produced by infection while examining a syphilitic woman.

Soft chancre may produce—(1) Simple or sympathetic bubo, from absorption of ordinary pyogenic organisms. The pus in this case, if inoculated, produces a pustule, but not a soft chancre.

(2) Virulent bubo, due to absorption of pyogenic organisms and specific virus. Pus from this bubo, if inoculated, will produce a chancre.

In these cases there is a great deal of peri-adenitis.

There are two schools of thought with regard to the relationship existing between hard and soft chancres.

A. **The Unity Theory** teaches that hard and soft ulcers are the product of the same micro-organism; it admits that the infective property of the soft is less than the hard, but claims that the former may produce constitutional symptoms.

B. **The Duality Theory** teaches that there are two distinct micro-organisms—that of Ducrez for the soft, and that of Schaudinn for the hard, chancre.

The latter is probably the correct view.

Vesicles or herpes may occur on the genitals of those who have never had syphilis, but are much more common in those who have had the disease.

Treatment of Chancres.—Hard: Mercury at once, internally and applied to the chancre.

Soft: Destroy with fuming nitric acid or the actual cautery. If soft chancres are multiple or of several weeks' standing, dust with iodoform or apply iodoform ointment (℥i. to ℥i.). This is the best treatment, but if it fail, mercurial applications are to be tried, and, failing these, cauterization with acid nitrate of mercury.

Phagedæna may attack both sores. It is not a true syphilitic process, but syphilis is the most fruitful cause of it. In appearance the ulcer spreads steadily in depth and area **owing to the irritation caused by its own secretion.** Its edge presents small irregularities as if "eaten by a mouse," and also minute points of slough. The sore is painful.

Treatment.—Fuming nitric acid and the continuous bath. Since phagedæna is a condition usually found with infecting sore, mercury should be given combined with iron and opium. If mercury does not agree with the patient, iodide of potash should be given.

Constitutional or Secondary Symptoms.

General Phenomena of Constitutional Symptoms.—In secondary syphilis the inflammation is temporary, and there is no tendency to tissue destruction; the reverse is the case in the tertiary period. Secondaries are symmetrical, because there exists general blood-poisoning; while tertiary symptoms are asymmetrical, because there exists not a blood-poisoning so much as a peculiarity which has been stamped on the tissues by what occurred at a remote period of blood-poisoning.

Primary syphilis is local in its manifestations; secondary is general; tertiary, again, more or less local.

The **Time** of the appearance of secondaries is from two to four weeks after induration appears in the chancre, or from seven to nine weeks after contagion.

If the two weeks after induration has appeared have been used for energetic treatment, no secondaries as a rule appear, or they will be delayed and feebly marked.

If treatment is not adopted, the following is the course of events: For about six weeks there is slight malaise with evening rise of temperature, during the following fortnight the skin of the chest and abdomen is mottled with evanescent patchy congestion—like measles, but more dusky and not so conspicuous. About the same time symmetrical superficial ulceration of the tonsils occurs; this may be transitory. As the roseola fades other types of eruption follow; a rash composed of little smooth-topped or scaly papules is the most common; or it may have the character of lichen, or be pustular; it may resemble impetigo or acne; or be vesicular or bullous, and thus assume the rupia type; and it may be corymbriform (lichen ruber), or simulate variola.

The **Contagion Period of Syphilis** is uncertain, but it probably lasts at least to the end of the secondary symptoms.

The semen is not infectious unless conception takes place; in other words, the disease is conveyed through the embryo.

Some authorities hold that the normal secretions of the body, with the exception of the semen, do not contain the micro-organism.

Others hold that they contain infection, but do not transmit it, unless through a broken surface. The semen is an example of this, as the woman escapes if conception does not take place and there is no broken mucous surface.

Others (Bristow and Lee) hold that only those organs yield infective secretions which are inflamed or syphilitic.

The truth seems to be that the normal secretions, with the exception of the semen, do not contain or transmit the organisms, and that the semen only transmits to the mother through the fœtus.

A second attack of syphilis is rare, but quite possible. When occurring, it is modified in form, and the chancre is comparatively soft and abortive.

Skin Eruptions.—These are usually very much mixed, and have a tendency to simulate true skin disease.

"Syphilis may imitate all known forms of skin disease, but it can produce no originals" (Hutchinson).

To **diagnose** them from non-specific eruptions, the following points should be noted:

(*a*) Colour: Not always "raw ham," though often observed.

(*b*) Symmetry: An irregular curve may be observed which follows the blood-supply.

(*c*) Polymorphism: Type is mixed.

(*d*) Position: Earliest, on the front of the abdomen; then, in order, the front of the chest, front of the arms, back and sides of the neck. In syphilitic psoriasis the front of the arm and the outer and back parts of the leg are usually affected; the reverse is the case in the non-specific variety. This rule, however, is not absolute; the only absolute rule is that **where we find patches of psoriasis on the tips of the elbows and the front of the knees it is not specific.**

(*e*) Flexor aspects affected.

(*f*) No itching or irritation.

The most common eruption is the **roseolous** on the abdomen.

Next in order is the **papular psoriasis.** It differs from the non-specific variety in (1) locality, (2) affecting small areas, (3) not being markedly scaly.

Next comes **lichen,** little red dusky pimples scattered over the whole surface of the body. They are closely placed, but not confluent; there is one form in which they are arranged in long streaks like **lichen ruber,** and sometimes these become flat-topped and polished like **lichen planus.**

Next in order comes specific **variola,** and next **rupia.** The latter is a heaped limpet-shell-like eruption; when taken off, a red base is left. It is a late secondary eruption, and scars left by it help the diagnosis in tertiary syphilis. It was formerly thought to be a tertiary symptom, because it often has an ulcerating base (ulceration or suppuration being usually associated with the third stage); but this only indicates the state of the patient's health, and shows the necessity for a tonic treatment rather than an antispecific one.

Rupia occurs in the second and third stages, but from different causes. It occurs as a skin disease in the second stage, and as a scabbing gummatous ulcer in the third.

Corneil's Classification of Secondary Skin Eruption.—1. Roseolous—abdomen and chest.

2. Papular. The corona veneris is a papular rash on the forehead.
3. Vesicular, one termination of the papular rash.
4. Pustular (variola, rupia); begins as a papular variety.
5. Squamous, simulating psoriasis.
6. Tuberculous, or warty.
7. Bullous, simulating pemphigus.

Affections of the Eye—Iritis.—Occurs from three to six months after the appearance of the chancre; the second eye is often affected after the other one has recovered.

Symptoms.—Ciliary congestion, muddy iris, irregular pupil, pain, photophobia, iritis, adhesions on using atropine.

Result.—Perfect sight when treated.

Complications.—The vitreous, choroid, and retina may become affected; these structures, however, usually suffer at a later period.

Diagnosis.—From rheumatic iritis by the history, there being less pain and photophobia, and the iris being less swollen and muddy. Effusion into the aqueous humour and dotted deposits on the back of the cornea may occur in both; there is no recurrence.

Treatment.—Dilatation with atropine drops (4 grains to the ounce) every three hours. Mercury by inunction or injection. Iodide of potash may effect a quick cure, but is less certain than mercury.

Diffuse Retinitis.—Usually occurs a year after contagion.

Symptoms.—Failure of sight, with muscæ and opacity of vitreous. There is little evidence of congestion or photophobia.

Objective Diagnosis.—Ophthalmoscopic examination and the history of the case.

Treatment.—Mercury pushed to ptyalism.

Patchy Choroiditis.—Symptoms and treatment as above.

Affections of the Mouth and Mucous Membranes.—*Transitory*: **Tonsil ulcers.** A kidney-shaped ulcer develops, with white-grey borders like

"snail tracks." This is the earliest constitutional symptom except roseola.

Warts and **condylomata** occur in the centre of the posterior portion of tongue; and condylomata on the anus and vulva.

Mucous Tubercles occur usually on the inner side of the cheeks, on the tongue, and at the corners of the mouth.

They are slightly raised patches of enlarged and infiltrated papillæ, white in appearance, owing to the superficial epithelium becoming sodden.

Condylomata are much the same as mucous tubercles, but there is a greater heaping up of papillæ, and they usually occur at the anus or vulva and on the dorsum of the tongue (Hutchinson's wart). Warts are practically the same as condylomata.

Treatment.—An antiseptic wash should be used for the mouth. For the anus and vulva iodoform should be applied locally, and constitutional treatment carried out.

Affections of Bones and Joints.—Periostitis occurs; it is, however, slight and transitory, thus differing from that of later periods. Nodes are rare.

Osteocopic Pains of varying intensity, accompanied by tenderness and slight swelling, occur in bones at this period; those usually affected are the bones of the skull, the tibia, and clavicle. The latter two are, however, more likely to be involved during the tertiary period. In patients liable to arthritic affections the joints will probably be attacked with acute pains of a rheumatic nature.

Treatment.—Mercury or mercury and iodide of potash, under which bone and joint affections clear up, leaving as a rule no after-effects.

Affections of the Hair and Nails—Alopecia.—May occur at this stage, associated with cracking and ridging of the nails.

Treatment.—Mercury, under the influence of which the hair grows normally again, and the nails recover their tone.

Affections of the Ear.—After inflammation of the tonsils and pharynx, a simple catarrh of the middle ear may occur, and may lead to suppuration. It occurs within one year of the onset.

A condition closely resembling **Menière's disease** is sometimes observed during the late secondary or tertiary stage. This is due to inflammation of the labyrinth, and may produce sudden deafness.

Treatment.—When the hearing is affected, it is necessary to get the patient promptly under the influence of mercury if the function is to be saved; for this reason it is well to combine inunction with internal medication. It is often wise to give large doses of iodide of potassium with the mercurial treatment.

Febrile Condition.—There is not as a rule much fever during this stage, but occasionally the temperature rises, even to 104° F., and continues high for some weeks. Fever is usually marked during an eruption of the variolous type.

INTERMEDIATE SYMPTOMS.

All the usual phenomena of the second stage pass away in most cases, under treatment, at the end of about six months.

Relapses, however, often occur, and the symptoms are called "**reminders.**" These are much less severe than secondary or tertiary symptoms, and partake of the character of both; thus, they are sometimes symmetrical, sometimes asymmetrical.

The following are the usual situations for reminders with the symptoms which are produced:

The Skin.—(*a*) A typical intermediary symptom is a slight and short-lived eruption of **erythematous rings** on the arms and trunk, which are specially noticed after exposure of the surface of the body to either heat or cold. The rash is evanescent, but returns again and again. (*b*) **Psoriasis palmaris:** This consists of peeling patches on the hands, not like true psoriasis, as they are seldom scaly. The eruption is not limited to one hand, while that of the third stage is.

The Testicle.—Sarcocele and **gumma** occur. If both testes are affected, the interval since the primary infection will be found to be short; if only one, the interval may be of several years' duration.

Specific affection of the testes is seldom seen in early second or late third stage; it belongs distinctly to the intermediary group of symptoms.

Sometimes there are enlarged masses in the epididymis, but more usually a general slow enlargement of the whole gland occurs, accompanied by little pain. Abscess formation leading to fungus testis may occur, if no treatment is adopted.

Diagnosis.—Swelling of the epididymis in the second stage, or as an intermediary symptom, is painful; while in the third stage it is painless and the swelling is hard, being a gummatous or sclerotic affection rather than an inflammatory one, as in the earlier stages. The swelling is of large size and smooth rounded outline; it is light, thus excluding hydrocele or malignant growth.

Treatment.—Even for very long-standing cases mercury and iodide of potash should be combined. Never excise the gland, even after fungus testis. Relapses are rare.

The Eye.—Choroiditis. Now is the time, if ever, for this to occur; it is, however, a rare affection. Gummata occur in the choroid, and may be seen by the ophthalmoscope. Patches of atrophy are left after treatment.

In other forms thinning and absorption of the choroid takes place.

There may also be inflammation of the retina and optic nerve, or this may occur alone.

Arteries.—Arteritis and **Endarteritis (Syphilitic Apoplexy).**

The **Symptoms** vary; the patient may suffer from something in the nature of a fit; usually, however, paralysis comes on slowly, owing to gradual blocking of the vessels, and tingling, twitching, or numbness are experienced for some hours, or perhaps for days, before paralysis sets in.

Pathology.—The arterial condition is one of thrombosis rather than of destruction of the wall of the vessel—hence the slowness in the onset of symptoms of paralysis. Inflammation of the arteries begins as an affection of the intima or adventitia, never of the media, though in some cases it spreads to that structure when it becomes thickened either in plates or over long tracts. The cell effusion is always excessive in specific endarteritis.

Diagnosis from Non-Syphilitic Endarteritis.—1. Thickening takes place, leading to narrowing or occlusion rather than dilatation and weakening of the artery (nevertheless, syphilis is a predisposing cause of aneurism).

2. Small vessels are chiefly affected.

3. The whole circumference of the vessel is involved.

4. The newly formed tissue becomes vascular, and does not undergo fatty degeneration.

As a primary and independent affection, disease of the intima is much the most common; if, however, the arteries are affected secondarily (involved in association with disease of the tissues through which they pass), the adventitious coat suffers first and most severely; it also suffers first if arterial disease be late in developing.

Prognosis.—Fairly good under efficient treatment.

Viscera.—All the viscera are liable to suffer during the latter part of second or the intermediate stage, and they may be affected even earlier. The symptoms are, however, very different from those of the third stage. The process is one of diffuse infiltration, with general congestion rather than the local growth of gummata. When the liver is affected, the blood-forming function is interfered with.

Nervous System.—The cerebro-spinal system may be involved before the tertiary stage, contrary to the old doctrine.

TERTIARY SYMPTOMS.

Tertiary syphilis, unlike primary and secondary, shows no sign of spontaneous cure of symptoms, but gradually spreads and increases.

Distinctive Features of the Third Stage.—1. Shows no sign of cure, if untreated.

2. Asymmetrical in manifestation.

3. Symptoms few in number, or even single.

4. Frequently seen after an interval of immunity of many years' duration.

5. Any tissue may be affected.

6. Specific virus has probably ceased to exist in the blood.

7. The disease is probably no longer transmissible.

Contagion.—In the **primary** stage the local lesion is alone capable of transmitting the disease.

In the **secondary** stage the blood and all fluid tissue elements contain the virus; the secretions, except the spermatozoa, do not, unless they are contaminated through an abraded mucous membrane, as often occurs.

In the **tertiary** stage contagion is possible, but not probable.

Thus, the disease may be divided into stages:

In the primary stage it is for a short time a local disease, or at least local in its manifestations.

PLATE LXXIX.

SUPERFICIAL GUMMATA OF ARMS.

An unusual case as to distribution and symmetry.

(Photo by Mr. Dewar.)

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In the secondary it is a universal or blood and tissue malady.

In the tertiary it is a disease of tissue, but not of the blood, and its manifestations are irregular. In many cases they are absent, and when they do occur, in a strong, if not an absolute, sense of the word, they are only local.

A tendency to suppuration is not peculiar to any one period of the disease; it may occur at any time if the remedy fail to curtail the malady. If the patient is enabled to bear mercurial treatment, by sending him to the sea, and in other ways promoting increased vitality, the tendency to suppuration is done away with.

Symptoms of the Tertiary Stage.—These are mostly of the nature of gummata. All possess the peculiar feature of tendency to local extension, to which, when it shows itself in the skin, the term **serpiginous** is given; all of them have a stage of sclerotic atrophy, or, in a few instances, of hypertrophy.

1. **Gummata.**—The formation of a gumma may occur in any viscera; in fibrous structures; in cellular tissue, as the meninges of the brain and spinal cord; in the capsules of joints; and in subcutaneous cellular tissue generally.

Pathology of Gummata.—The situation may or may not be determined by an injury. The morbid area is the seat of a round-celled infiltration, the cells being derived (*a*) from cells of connective tissue, and partly from (*b*) leucocytes. It gradually increases in size, the normal tissue disappearing before it; a few bloodvessels find their way into this mass, otherwise it is like granulation tissue. The blood-supply is cut off by the spreading cicatrix, and the gumma now consists of a central yellowish slough, devoid of vessels, formed by the oldest portion of the growth in a state of fatty degeneration and necrosis; surrounding this is a zone of loose vascular fibro-cicatricial tissue, while the periphery of the tumour is constituted of a round-celled hyperæmic infiltration of the normal tissues. Under treatment the whole mass may (*a*) disappear, (*b*) break down and burst, (*c*) become encysted in a fibrous capsule. This termination is most common in the brain, testis, and liver.

Gummata may be (*a*) **cutaneous,** when they are common about the knee, and occur as dusky red nodules of firm consistency; or (*b*) **subcutaneous,** when they are felt as hard masses, which usually push their way to the surface, and eventually ulcerate.

2. **Periostitis.**—Chronic and relapsing, leading to nodes or sclerotic hypertrophy of bone, or, if neglected, to suppuration and necrosis.

3. **Muscular Nodes.**—These occur in the substance of muscles, and may simulate tumours.

4. **The Skin.**—Affections of a lupoid nature take place; they are gummatous or tuberculous in character at first, serpiginous later, and leave scars.

A diffuse infiltration is sometimes met with at this stage which closely resembles **lupus;** the apple-jelly-like granulations are, however, absent.

5. **The Tongue.**—This organ is affected by the formation of gummata, superficial or deep, usually situated towards the middle of the dorsum. In addition, there occurs a **sclerosing glossitis** (Fournier), in which there is a large new formation of connective tissue in the substance of the tongue.

6. **Nervous Tissue.**—This is affected with gummata and degenerative changes.

7. Conditions implying general tendency to **Tissue Degeneration** arise, as amyloid disease.

8. Chronic inflammations of **Mucous Membranes** take place. If the process is diffuse, sclerosis occurs; if local, a gumma is formed.

9. **The Ear.**—Ulceration and gummata may occasion deformity of the auricle or stenosis of the auditory canal.

The late results of syphilis poisoning are a general degeneration and the manifestation of grave changes in nerve tissue, known as **quaternary** or **parasyphilis,** as seen in the development of **tabes dorsalis** and **general paralysis of the insane.** These conditions do not develop where careful treatment has been carried out from the commencement of the disease, and persevered with for a sufficient period.

By the term **malignant syphilis** is understood a type of the disease in which the skin, bone, and nerve changes are profoundly marked.

TREATMENT OF SYPHILIS IN GENERAL.

The old classical treatment will first be considered. Treatment by modern methods is dealt with later.

In the early stage of syphilis mercury should be used; iodide of potash is then comparatively useless; so also in the second stage, except in certain cases of **sores in the mouth and throat,** mercury should be given; but for all tertiary gummata iodide of potash is the drug to be used, though in exceptional cases mercury is better borne. Perhaps the best treatment for the third stage is a combination of the two drugs.

With regard to dosage, there is no doubt that small, long-continued doses are the proper rule for mercury; as to the iodides, the amount of the dose does not seem of much moment, though it may be taken as a working rule to begin with 5 grains, and work up to a large dose, if the patient can stand it and the symptoms not seem to abate with a small one. The fear of causing atrophy of the sexual organs by the prolonged use of iodide of potash may be regarded as groundless, though the drug certainly has a general depressing effect on many persons, and in some acts upon the sexual function. It should be clearly understood that the effect of the iodides is to cause the small cell infiltration to be absorbed, not to cure the disease, as is the case with mercury.

Mercurial Treatment.—The usual method of general administration of the drug is by the mouth as a pill containing 1 grain of grey powder and 1 grain of Dover's powder (hydrarg. cum crete, gr. i.; pulv. ipecac. co., gr. i.). The latter prevents griping. One of these pills may be taken twice daily.

If it is wished to increase the amount of the drug, it is better to give it more frequently rather than to augment the dose.

During mercurial treatment the teeth and gums should be washed carefully several times a day with an antiseptic solution. All **green vegetables and fruit, aperients, coffee, alcohol,** and **tobacco,** should be forbidden. Tobacco increases the risk of mucous patches, and tends to make sores in the throat more difficult to heal; and fruit and other articles with a like action may cause diarrhœa.

If a patient is much in the open air the cure will become somewhat delayed. Tonics should only be given when absolutely necessary, because they enable the system to resist the action of mercury. Ptyalism is, however, to be avoided. When produced, it may be combated by giving tabloids containing $\frac{1}{100}$ grain of atropine thrice daily till the pupils dilate.

Rupia is most likely to occur in those who have had a short strong course of mercury, followed by its complete suspension.

The **chancre** usually requires about a month's treatment with mercury before the induration completely disappears.

If treatment is begun before secondary symptoms have shown themselves, it is unusual for them to appear. **Sore throat** is the symptom least often omitted; the skin usually escapes. If, however, within a period of six months mercury be suspended, in a few weeks a rash may show itself. It is usually slight, and its mildness seems to correspond with the length of time the patient has been under mercury. When mercury is given by the mouth in long-continued small doses, relapses are seldom seen. As regards the whole influence of mercury in syphilis, it is requisite that it should be brought into contact with the cell elements concerned in the morbid process, as wherever its local application is practiable we know that its effect is very marked.

In debilitated subjects who cannot stand long courses of mercury or the iodides, **Zittman's** method of treatment may be tried; it consists of giving large doses of sarsaparilla in copious quantities of water at intervals of mercurial treatment.

Details of Mercurial Treatment—Primary Sore.—Black wash, applied on a piece of lint or gauze, which should be frequently changed. Equal parts of calomel and salol, or of iodoform, may be dusted on as alternatives.

Internal treatment should be commenced when the chancre becomes indurated.

Secondary Eruption.—Inunction is useful when the case is first seen at this stage, combined with internal administration; for inunction, ammonio-chloride of mercury 15 grains to 1 ounce of lard may be used.

Inunction.—This is the method adopted at Aix-la-Chapelle, and the wonderful results there achieved are largely due to the fact that the patient is kept under constant observation, and is frequently confined to bed. About 3 grammes of strong mercurial ointment is rubbed into the inner side of the thigh and arm. The ointment should be rubbed into different parts on successive days to avoid unduly irritating the skin; after inunction, the patient should put on a flannel gown and go to bed without a bath.

An important use of mercury by inunction is in treating children, on whose binder a portion of the ointment about the size of a walnut is placed, and the child allowed to rub it in by his, or her, own movements.

Fumigation.—In this form of administration the patient is made to sit over a lamp upon which about ½ drachm of pure calomel has been put. The calomel is sublimed by the heat in company with watery vapour, and is deposited on the patient's skin.

The advantages of these two latter methods of giving the drug are

(*a*) that it is less likely to purge or cause colic—this can, however, be easily avoided in giving it by the mouth—and (*b*) that the patient is more quickly brought under the influence of the drug. The disadvantage is that the patient requires to be under close observation.

Hypodermic Injection.—This method was adopted by the Italian school, and is not extensively used in England. If the drug is being administered in this way, the following precautions should be taken:

1. In order to prevent irritation and abscess formation, the injection should be made into the muscle, and not into the cellular tissue; the gluteus maximus is usually chosen.

2. The needle should be washed after the syringe has been charged, so that none of the fluid touches the skin during introduction.

The dose is—$\frac{1}{3}$ grain of bichloride of mercury dissolved in 20 drops of water once a week. Three such injections will usually salivate freely. The solution should always be freshly made.

Treatment by the Iodides.—Iodide of sodium depresses less than the potash salt, and it is often well to combine it with the latter, and also to add sal volatile to the prescription, as a stimulant, and to lessen the iodide rash. It is useful in many cases to combine mercury with the iodides in the form of the liquor of the perchloride, 1 drachm of which equals $\frac{1}{16}$ of a gramme of the salt.

It is always well to begin with a small dose of the iodides, gradually working up to a larger one. As a rule iodide of potash is better than mercury in tertiary symptoms, but the latter often acts well when the iodides fail; especially in syphilitic gumma of the brain, testis, and lung. When the latter organ is affected, it is usually the middle lobe, thus differing from tuberculosis, the symptoms of which are simulated.

Untoward Results of Iodides.—(*a*) **Coryza** is the commonest of these. It may be very profuse at first, but lasts only a short time; in other cases the patient may suffer from a chronic "cold in the head" so long as he uses the drug. It is well, then, to try and effect a cure with mercury alone, or with very small doses of the iodides.

(*b*) The **Skin Eruptions** which may be produced by the iodides are very various; they show little relation to the dose employed, and are undoubtedly largely due to idiosyncrasy. It is wise to employ tonics and fresh air freely during the use of the iodides.

(*c*) **Depression,** which in some cases may be marked. The addition of the aromatic spirits of ammonia very often prevents this, and the other symptoms of the iodism.

Special Treatment for Special Symptoms—Ulcers of the Mouth or Throat.—In the second stage mercury should be given internally, black wash used as a gargle, and the sores dusted with calomel and salol. If they prove intractable, they may be touched with acid nitrate of mercury. If very painful, mercury may be at fault, and the iodides should be substituted. Smoking must be prohibited.

Ulcers of Throat in Intermediate or Third Stage.—These are often phagedænic. Potash should be given freely. Iodoform may be applied locally with a brush. If the sore persist, it may be touched with acid nitrate of mercury.

Iritis and Other Eye Symptoms in Second Stage.—Mercury should be pushed, and atropine used freely.

Ulcerating Secondary Eruptions of Rupial Type.—Mercury combined with potash; if this is not successful, inunction or fumigation is to be tried. Iodoform ointment should be used locally for the sores.

Phagedæna in all Forms and Stages.—Locally iodoform, nitric acid, cautery, antiseptic bath. Mercury and potash should be given, combined with opium. If all these measures fail, the patient should be sent to the seaside.

Disease of Arteries (indicated by cerebral attacks).—Inunction or hypodermic injection.

Periostitis and Other Forms of Bone Affection.—Iodides are the most useful, but sometimes mercury will succeed where they fail.

In periostitis, the result of congenital syphilis, the same treatment is adopted, but good results will be slower.

Tertiary Lupoid Affections.—Iodoform ointment or acid nitrate of mercury is applied. Iodide of potash should be given internally; if not successful at once, mercury should be substituted.

Congenital Phagedænic Lupus.—This is cauterized freely with acid nitrate of mercury, and dressed with iodoform ointment. Iodide of potash and bark should be given internally.

Congenital Interstitial Keratitis.—A long course of small doses of mercury and bark; atropine or belladonna, fomentations; sea or country air.

Locomotor Ataxia and Other Central Progressive Nerve Diseases.—Mercury in doses to produce slight ptyalism. If benefit result, repeat in combination with iodide of potash after a month's interval; or probably a better line of treatment is to give smaller doses for a period of one year.

In cases which resist mercury, and in which it is wished to produce **ptyalism rapidly,** the hypodermic method is used; or mercury administered by the mouth and by inunction, and the patient made to stay in bed.

In **pregnancy,** where it is desirable to protect the fœtus, small doses of mercury may be given right through the period; there is no direct evidence that this injures the child's teeth subsequently.

In cases where **marriage** is contemplated, mercury is used throughout the period of treatment, which should be for two years after contracting the disease. If iodide of potash is necessary, avoid giving it in excess.

Rule as to Length of Treatment.—Eighteen months on mercury, and six months on mixed mercury and iodide of potassium, whether tertiary symptoms appear or not.

Rule for Marriage.—At least two years after treatment was begun, and six months after the last symptom has disappeared.

In every obscure visceral and tissue disease in those who have suffered from syphilis, **try mercury and iodide of potash.**

Bier's Hyperæmic Treatment.—Up to the present there has been little investigation as to the effect of this treatment on hard chancre. It is possible that by its means the disease might be prevented from developing its secondary constitutional manifestations. It would, however, in the present state of our knowledge, be very unwise to depend upon it alone. And when used in combination with mercurial treatment, it is difficult to apportion the credit to one or the other. The method would seem to be of little benefit in soft chancre.

CONGENITAL SYPHILIS.

There is no primary sore, the virus passing directly "from the fluids of the parent to those of the child."

The living virus exists in the child at birth, but may not show itself for long after; as a rule, however, the disease is manifest three or four weeks after birth.

Laws of Inheritance.—The ovum may be infected **at the time of conception** (conception inheritance)—

(*a*) From the father alone (sperm infection).

(*b*) From the mother alone (germ infection).

(*c*) From both simultaneously.

(*d*) Later, from the mother's blood the fœtus may be infected during pregnancy (pregnancy inheritance).

The resulting disease in the child seems in no way altered by the mode of inheritance, nor yet by the stage of the disease reached by the parent, unless it be the third stage.

There is no truth in the assertion formerly made, that the younger children inherit from a syphilitic parent a milder form of the disease than the elder, but the first-born children are more likely as a rule to inherit than the younger. Heredity is irregular, sometimes skipping one child and appearing again in a younger one.

Parents who have reached the third stage do not transmit, though they themselves may have symptoms of the disease.

A child is much more liable to inherit from the mother than the father, for in the former case there is the double risk of conception and pregnancy inheritance.

Colles' Law: "Syphilitic children will often infect a non-syphilitic wet-nurse, but never an (apparently) non-syphilitic mother." The reason for this is that a woman bearing a syphilitic fœtus, inheriting from its father, though she may remain free from symptoms, acquires gradually a state of constitution which protects her from the disease. Or, as some think, she really has the disease, and so is protected.

Evolution of Hereditary Syphilis.—The fœtus as a rule remains healthy during intra-uterine life.

At the end of three or four weeks of extra-uterine life, coryza (snuffles) makes its appearance, and is quickly followed by some skin eruption, attended with wasting and fretfulness of temper.

The primary symptoms in infants are the secondary of adults. They are amenable to mercury, and present much the same characteristics as in the acquired disease.

There are, however, certain peculiarities of the hereditary symptoms which are probably due to the very young age of the patient and the incomplete development of the tissues. Thus, the general health suffers much more than in the acquired form, and death is not an infrequent consequence. Periostitis of a definite form occurs, with pains of a rheumatic type, and in the case of the epiphyses of long bones, may result in abscess formation; while in the case of the skull bone thinning frequently occurs in one part, and thickening in another.

In consequence of the fatness of young infants, the eruptions are apt to assume the character of *intertrigo*.

Symptoms.—The character and colour of the skin rash, its location

and symmetry, combined with snuffles and with wasting, point to the condition present. Patches occur on the various mucous surfaces.

The bones are subject to pain and the development of nodes, while abscess formation may take place, or sclerosis of the bone occur.

There is often wasting of the muscles.

If the infant survive the first outbreak, there will usually be an interval of some years without any symptoms, and in some cases none will show themselves till the tertiary ones appear. A group of peculiar symptoms will then occur, especially with regard to the organs of special sense.

Tertiary Symptoms of Congenital Syphilis—The Ears.—Subjective noises are heard, there is no discharge or pain, the condition is usually bilateral, and almost total deafness may be produced. Cases treated early may recover, but if once the deafness is complete, it seems to be incurable. This affection does not usually occur before puberty.

The Eyes.—About the same period of life, but with wider time-limits, there is a remarkable tendency to a very peculiar inflammation of the cornea. **Interstitial Keratitis** in its typical form is always a consequence of syphilis, and it is in itself sufficient for the diagnosis of the disease. It must, however, be carefully diagnosed. It begins with cloudiness of the substance of the cornea, with ciliary congestion and irritability; the clouds increase and coalesce till the whole cornea looks like ground-glass. The affection begins in one eye, but in the course of a few weeks attacks the other. It is always in the end symmetrical, though in rare cases the interval between the attacks in the two eyes may extend to years. Usually complete recovery takes place, though total blindness may for a time result.

The Joints.—At this time the patient often suffers from synovitis of one or more large joints; the knees are most often affected. The condition is not accompanied with much pain.

The Bones.—Periosteal affections of the long bones are not uncommon at this stage, and are as a rule severe; they may occur in any part of the skeleton, and often produce numerous and large nodes. If near to joints, these nodes may be productive of much crippling of movement. If situated on the shaft, they may produce an appearance of curving, which used to be mistaken for rickets. Overgrowth of the bone in length as well as thickness is an almost constant result of this form of periostitis, since it often persists for years. Occasionally suppuration occurs, which may be diagnosed from ordinary suppurative periostitis by the fact that there is no involucrum formed, and that the sequestrum is very slow to separate, often remaining visible, but firmly fixed for a year or more.

The Skin.—The only form of skin trouble likely to occur at this stage is a rapidly destructive lupus.

The Mucous Membranes, Tongue, and Palate.—Affections of these are very rare.

Visceral and Nervous Diseases.—Rare.

The subject of inherited syphilis does not transmit to the offspring, and usually, after the tertiary symptoms are recovered from, goes on to the end of life with apparently no ill-result.

Intra-Uterine Syphilis.—There can be little doubt that death of the fœtus is due to the disease in the mother, or the placenta. There are, however, rare cases in which the fœtus exhibits lesions of **viscera,**

bones, or **skin,** proving conclusively that it is suffering, or has suffered—for they are almost always born dead—from syphilis.

Diagnosis—(*a*) **In the Fœtus and at the Time of Birth.**—It is often far too quickly assumed that, if a dead fœtus shows a peeling and shrivelled skin, it has probably died from syphilis. Such conditions are common whenever death has occurred, from any cause, long before expulsion.

The weight of modern evidence is against living infants being born with eruptions or other evidence of syphilis; nevertheless, Rodilot Doublet, Gilbert, Guerard, and Landman, have all published such cases. Diseases of the liver, spleen, thymus gland, etc., have all been encountered under circumstances pointing to the virus having been actively working in the fœtal organism during intra-uterine life.

(*b*) **During Early Infancy.**—In many cases the recognition of inherited syphilis at six or eight weeks is easy.

The stuffed and expanded nose, the presence of snuffles, pallor, patches of peeling erythema about the face, neck, and nates, constitute a picture which can scarcely be mistaken; and one which is often more clearly painted by such symptoms as sores at the angles of the mouth and at the anus, a peculiar odour, and periosteal tenderness of various bones.

All cases, however, are not so typical, and in some the diagnosis may be very difficult. In such cases help must be sought from the parents' history, and from facts as to previous births or miscarriages, if there have been any.

Bone lesions are common though transitory, and must be diagnosed from rickets. In syphilis the lesions occur at an earlier age and are attended by more definite signs of inflammation, are not accompanied by other phenomena of rickets, such as profuse sweating of the head and "buttons" on the costal cartilages.

It must be remembered, however, that inherited syphilis and rickets very often coexist, but have nothing directly to do with each other. For purposes of diagnosis it may be sufficient to state that it is common to find certain areas in the skull tender and slightly swollen, and that the region of the epiphyses of long bones often suffer in a like manner; the swellings near joints are always larger and more inflamed than those of rickets.

The soles and palms should be examined for peeling patches, and the nails for malformation.

(*c*) **At Periods of Life Subsequent to Infancy.**—After the infantile phenomena have passed away (about the end of the first year), the recognition of the subject of inherited syphilis will depend—

1. Upon certain structural peculiarities which have been left as the result of the secondary lesions.

2. Upon the occurrence of new local inflammations which are characteristic of the disease.

To take the latter first, it may be broadly stated that if a child, not the subject of earache or otorrhœa, becomes quickly and completely deaf, the patient is almost certainly syphilitic. The diagnosis is also pretty clear if the patient shows symmetrical interstitial keratitis, erosive lupus, or ulceration of the palate, multiple chronic nodes of long bones and disseminated choroiditis.

If during infancy the child has escaped from specific inflammation of any tissue, then it is probable that nothing may be seen in the

physiognomy to indicate the disease. If, however, the child has had the usual infantile manifestations, in all probability the physiognomy will have received an impress which is seldom effaced in after-life; the skull may be peculiar in form, the texture of the skin modified, scars may exist about the mouth and anus, and the teeth may be malformed.

The picture of structural peculiarities is often diagnostic: Square forehead with prominent frontal eminences "like budding horns"; the sunken nose; the soft, pale, earthy-tinted skin and the scars at the angles of the mouth. If the case comes under observation after keratitis has occurred, very conspicuous signs will have been left behind in the eyes. The irides look steel-grey, the cornea is not brilliant, and there is a slight tendency to frowning, consequent on prolonged intolerance of light.

The Form of Skull.—There is exaggerated prominence of the frontal eminences, while between them and the eyebrow is a furrow, or depression. Posteriorly on the parietal bones similar eminences exist; they are, however, more widely spread and lower, constituting the natiform skull of Parrot. As a whole the skull is larger than normal.

The cause is probably chronic infantile periostitis with softening, and frequently a tendency to hydrocephalus.

The bridge of the nose is flattened, consequent upon internal and external periostitis of the nasal bones.

The Skin.—The integument of the whole face is of an earthy pallor; the skin is thin, soft, and wanting in resiliency; often there are little pitted scars in various parts, and specially round the mouth, and at its angles radiating linear scars are to be observed.

The Teeth.—The upper central incisors are dwarfed; they are too short and narrow, and display a single central cleft in their free edge. One or more of these signs may, however, be absent. Usually the condition is symmetrical. The lateral incisors rarely show any peculiarity, but are sometimes dwarfed. The upper central incisors are most frequently deformed, but the lateral and inferior ones may also be affected.

The differences between mercurial and syphilitic teeth are marked. The former condition is due to inflammation of the tooth pulp, and results in defects of development of the enamel, causing transverse ridges on the incisors, but specially on the crowns of the first molars, while the latter is an arrest of development, causing the teeth to be narrower and shorter than normal, and to have a central notch, which is often at first partly filled up by dentine, and gradually breaks away. These changes are only seen in permanent teeth, the bony crown of milk-teeth being too far advanced when either poison begins to act. Any defect in the milk-teeth is probably due to intra-uterine causes; thus, premature decay may be due to mercury administered to the mother during pregnancy.

Prognosis.—Good, in good-class patients, but death is fairly common in the uncared-for children of the poor. Should death occur, it usually happens soon after birth, and before treatment has had time to take effect. Severe after-effects are rare in inherited syphilis. In some cases obscure affections of the nervous system are seen.

No subsequent skin affection, with the exception of lupus, is due to inherited syphilis.

Treatment of Infantile Syphilis.—Mercury by inunction is the best method. Against giving it by the mouth are the two facts that it is apt to purge, and the uncertainty as to a child getting a proper dose.

Ten grains of strong mercurial ointment may be rubbed into the soles and palms night and morning, or double the quantity put on the binder. Hutchinson states that treatment should be stopped shortly after the symptoms disappear. The secondary symptoms of inherited syphilis are much less liable to relapse than those of acquired, and mercury should not be continued too long, as it tends to injure the permanent teeth; while iodide of potash is too depressing for infants, and is uncertain and often inefficient. Mercury usually benefits the general health of the child.

SUMMARY.

Primary Syphilis is a disease with local manifestation, and is characterized by—

1. Local, hard, single chancre.
2. Hard, bullet-like bubo.

Secondary Syphilis is a constitutional disease, and is characterized by—

1. Various forms of rash on the skin and mucous membranes.
2. General enlargement of lymphatic glands.
3. Sore throat.
4. Mucous tubercles and condylomata.
5. Loss of hair.
6. Anæmia on account of deficiency in the number of red corpuscles and the diminished hæmoglobin in the remainder.

Later than Above:

7. Osteocopic or flying pains in bones.
8. Iritis.

Late Secondary or Intermediate Symptoms:

1. Deep lesions of the eye—choroido-retinitis.
2. Deep lesions of central nervous system—monoplegia. (Due to anæmia from endarteritis of cerebral arteries.)
3. Psoriasis, either bilateral or unilateral. It is a more severe form than the secondary, and not so readily benefited by treatment.
4. Rupia and ecthyma are later symptoms; there is no excessive scab formation.
5. Subacute symmetrical epididymitis, in which the cord is also thickened, enlarged, and tender.

Tertiary Syphilis is a disease with local manifestations, and is characterized by—

1. Cutaneous gumma—lupus syphilitica.
2. Subcutaneous gumma; central gumma.
3. Endarteritis.
4. Disease of lymphatic glands.
5. Disease of muscle.
6. Disease of joints and bones.

7. Disease of the pharynx and larynx.
8. Disease of the tongue.
9. Disease of the rectum.
10. Disease of the testis.
11. Disease of the brain (gumma).
12. Disease of the lungs, which resembles phthisis, but attacks the middle lobes.

Any tissue or organ may be affected, except the pancreas, in the course of tertiary syphilis.

Inherited or Congenital Syphilis is characterized by—

1. Absence of primary chancre.
2. The appearance during the first year of any or all of the secondaries. A special symptom is a catarrhal rhinitis which causes "snuffles."
3. After the first year any tertiary symptom may be present, but special features are—

(*a*) "Hutchinson's teeth." The peculiarity appears in the permanent teeth.

(*b*) Bone disease.

(*c*) Interstitial keratitis (diffuse inflammation of the cornea), which occurs at puberty, first one eye, then the other, being affected.

(*d*) Ear trouble, producing deafness, occurs about the same time as the eyes are affected.

It must, of course, be clearly understood that all the stages are one and the same disease at different periods of its manifestation.

RECENT METHODS OF DIAGNOSIS AND TREATMENT OF SYPHILIS.

Of recent years laboratory work has come to the aid of the surgeon in the diagnosis and treatment of syphilis. Modern research can be divided into several stages:

1. *Schaudinn's* discovery of the *Spirochæta pallida.*
2. *Roux and Metchnikoff's* discovery that the disease is transmissible to some of the lower animals.
3. *Wassermann's* application of the Bordet-Gengou reaction to the diagnosis of syphilis.
4. *Ehrlich's* discovery of Salvarsan.

The discovery of the organism and the recent easy methods of its demonstration have rendered the diagnosis of syphilis easy even in the earliest stages. The transmission of the disease to animals has possibly done more for research in syphilis than anything else, as it rendered easy experimental work in this disease, and so paved the way for the other more practical advances.

SECTION I.—LABORATORY METHODS OF DIAGNOSIS OF SYPHILIS.

I. DEMONSTRATION OF THE SPIROCHÆTA PALLIDA.

The *Spirochæta pallida* is a delicate spiral filament 6 to 15 μ long. The spirals are numerous (10 to 26), and are maintained when the organism is at rest, thus differing from many other spirochætes. It is actively motile. The movements occur in three ways:

1. Rotation around a longitudinal axis.
2. An undulating movement.
3. A forward and backward motion in the surrounding fluid. This movement is a slow one, so that the organism can be observed for a considerable time in one field of the microscope.

For purposes of diagnosis the demonstration of the spirochæte is especially useful in primary chancres, as here the organisms are as a rule present in large numbers, and because in this stage the serum test for syphilis is not so valuable as in the later stages. They can be demonstrated with ease, however, in secondary lesions such as condylomata or mucous patches. This method of diagnosis is useless in lesions such as the ordinary secondary rash, or in tertiary manifestations.

Methods of Demonstration.—1. Staining methods, especially with Giemsa's stain.

2. Silver impregnation methods.
3. Burri's Chinese ink method.
4. By means of the dark-ground condenser.

The first two methods are now little practised, as No. 1 is unsatisfactory owing to the small affinity the organism has for stains, while No. 2 is tedious and uncertain.

Burri's Method.—This is dependent on the fact that Chinese ink when spread out on a slide makes a dark film around any solid particle suspended in it, so that the latter appears as a clear space on a dark ground. A small quantity of serum is placed on the end of a slide, rapidly mixed with about twice the quantity of ink, spread on the slide in a thin film, dried, and examined under a $\frac{1}{12}$ inch objective. The film must not be too thick, else the organisms are overlaid with ink, while if it is too thin a sufficiently dark background is not obtained. The correct density of film will appear a dark brown colour by transmitted light.

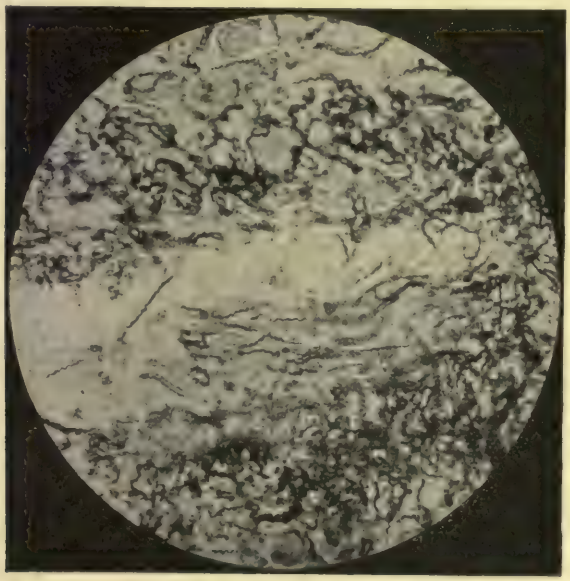


FIG. 139.—SPLEEN FROM A CASE OF CONGENITAL SYPHILIS, SHOWING NUMEROUS "SPIROCHÆTÆ PALLIDÆ." × 1000.

(From Beattie and Dickson's "General Pathology.")

The ink ought to be sterilized by steaming, and well centrifuged to remove organisms and larger particles. It can then be stored in a tube, and for use samples are taken from the upper layers.

Dark-Ground Illumination Method.—The principle of this is that a special condenser is fitted to the microscope, which cuts off all direct rays, and only allows very oblique rays to fall on the object under examination. Some of these are reflected from the sides of the object through the microscope to the eye. Thus the spirochæte is seen as a bright object on a dark field.

Some fluid from a chancre is placed on a slide, diluted if necessary with some salt solution, and covered with a *clean* cover-slip. Connection is made between the slide and the condenser by means of a drop of cedar-wood oil. For diagnostic purposes it is best to use a $\frac{1}{6}$ inch objective and a rather high power eyepiece (× 8). A good illumination is essential. When the condenser and mirror have been properly arranged, spirochætes can be seen as clear spirals, the appearance and movement of which can be observed.

Burri's method has the great advantage that it is very simple, and in most cases it is quite satisfactory. The dark-ground condenser method is more troublesome, but is more accurate, in that the characteristic movements of the spirochæte can be studied.

II. WASSERMANN'S REACTION.

Complement Deviation.—When an antigen is injected into the body, there results the production of **immune bodies, or amboceptors,** specific for that antigen—*i.e.*, they have no action on any other antigen. These amboceptors are so called as they serve to link up the **complement** of fresh serum to the antigen. They are not destroyed by heating to 56° C. for half an hour, as the complement is, nor do they disappear on keeping the serum. A person infected with a disease produces the specific amboceptors in the same way as the immunized animal, and it is for the detection of these specific amboceptors that the complement fixation test is used. So far as it concerns practical surgery it is applied mainly to two diseases—syphilis and echinococcus diseases (hydatid cyst); and as the former is by far the most important, the description of the test will apply to it particularly.

The complement deviation test was the direct result of the work of Bordet and Gengou in 1900, and the whole reaction has been called the **Bordet-Gengou phenomenon.** These workers formulated the general law that, **when an antigen was mixed under suitable conditions with its corresponding amboceptor and some complement from fresh serum, the complement would be bound up with the antigen, so that it would become ineffective if a fresh antigen and amboceptor were introduced.**

In 1906 Wassermann applied this law to the diagnosis of syphilis, and the test which he devised has come to be called the "Wassermann reaction."

The Wassermann Reaction.—For this reaction two systems of antigen and amboceptor are required—the syphilitic system and the hæmolytic system. The second is merely for the purpose of indicating whether the complement has been fixed by means of the syphilitic antigen. The test is done in two stages. In the first the syphilitic antigen is mixed with complement (fresh serum) and the serum from a syphilitic patient (containing amboceptor). This mixture is incubated, and then to it is added the hæmolytic system, consisting of sheep's washed red corpuscles and some inactivated serum from a rabbit which has been immunized by the injection of sheep's corpuscles (containing hæmolytic amboceptor). If during the first period of incubation the complement has been bound up to the syphilitic antigen, then it will be unable to act with the hæmolytic amboceptor to cause hæmolysis of the sheep's corpuscles. If, on the other hand, the patient's serum does not contain any syphilitic antibody, the complement will not be so bound up, and will be free to act with the hæmolytic amboceptor, and so cause solution of the sheep's red corpuscles.

Many methods of performing the test have been introduced since Wassermann first showed its usefulness. Good results can be obtained with almost all of these, but the simplest in its performance and the one most suited to the worker outside a large laboratory has been described by the author.

Description of the Test.—Three things are required:

1. **Antigen.**—This is made by grinding up with alcohol (90 per cent.) some heart muscle in the proportion of one of muscle to five of alcohol. The heart is extracted for one hour at 60° C., and the supernatant fluid is used as the antigen. The antigen keeps well for a considerable time, and must be diluted to the proper strength immediately before use.

This antigen must be standardized by testing various strengths of the extract (15 per cent., 10 per cent., 5 per cent., $2\frac{1}{2}$ per cent.) in salt solution, with a normal serum and a serum which is known to give a positive reaction. That strength is chosen which completely fixes the complement of the syphilitic serum without affecting the hæmolytic power of the normal serum.

2. The **Serum** of the patient and the normal serums are obtained from the finger by means of the ordinary blood-capsules.

3. The **Sheep's Blood** * is readily obtained from the butcher or slaughter-house. The corpuscles are washed by repeated centrifuging, and they are finally diluted to 5 per cent. in normal salt solution.

The test is done in small test-tubes, which are made by drawing out a piece of 6-millimetre-bore glass tubing into lengths of about 1 inch

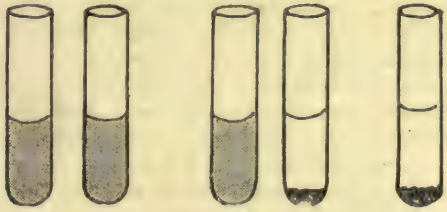


FIG. 140.—WASSERMANN REACTION.

1. Salt solution	+	Normal serum	+	Sheep's corpuscles	=	Hæmolysis.
2. Antigen	+	„	„	+	„	„	=	„
3. Salt solution	+	Syphilitic serum	+	„	„	=	„
4. Antigen	+	„	„	+	„	„	=	„
5. „	+	Sheep's corpuscles				=	„

and sealing off the ends of each of these lengths. These are each broken into two halves which have the form of miniature test-tubes. These tubes are now arranged in two rows; into each tube of the front row is put 4 volumes of normal salt solution (the exact amount of a volume is immaterial, but in practice 10 cubic millimetres is a convenient quantity), and into the back row is put 4 volumes of the antigen diluted to the proper strength. One volume of a normal serum is now added to the first tubes of each row, and to the second tubes of each row is added 1 volume of a syphilitic serum. One tube of each row receives no serum. These mixtures are incubated for one hour, and then to each tube is added 1 volume of the 5 per cent. suspension of sheep's corpuscles, and the incubation is repeated for another hour. The results will then be hæmolysis in all the tubes which received serum, except No. 2 of the second row, in which there will be no hæmolysis. There will be no hæmolysis in those tubes which receive no serum.

The Wassermann reaction gives positive results in practically all cases of secondary, tertiary, and congenital syphilis where there are any active lesions. In primary cases about 70 per cent. give positive

* Sheep's blood keeps well for a week or more if formalin is added to it up to 0·3 per cent.

reactions, but here the reaction is not of such importance, as in primary cases it is an easy matter to find the *Spirochæta pallida*. In general paralysis of the insane it is always positive, while in tabes positive results are only obtained in about 65 per cent. of cases.

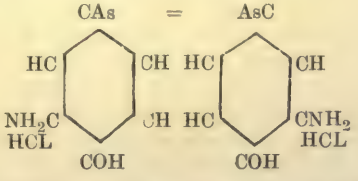
In General Paralysis and Tabes Dorsalis the *cerebro-spinal fluid* gives a positive Wassermann reaction, and for the diagnosis of these conditions an examination of the spinal fluid is of much greater importance than a test of the blood serum. When testing the spinal fluid it must be remembered that this never contains any complement, so that some fresh serum must be added to supply the deficiency. In both of these diseases there is a considerable *lymphocytosis in the spinal fluid.* Normally, lymphocytes are almost completely absent, and anything over 10 per cubic millimetre can be taken as abnormal, but in General Paralysis especially, and in Tabes to a lesser degree, the numbers are greatly increased up to several hundreds per cubic millimetre. There is also an increase in the *Globulin* present in the fluid, as shown by a definite precipitate when an equal amount of a saturated solution of Ammonium Sulphate is added.

Under the influence of efficient treatment the reaction as a rule disappears; but it may be that this disappearance is only temporary, so that it is advisable to test again six months or a year after treatment has ceased, as in all probability, if the disease has not been completely eradicated, the reaction will have returned in that time. The relative value of the different forms of treatment as measured by their influence on the serum reaction would seem to be as follows:

1. Salvarsan.
2. Injections of calomel or grey oil.
3. Inunction.
4. Pills or mixtures.

SECTION II.—TREATMENT OF SYPHILIS BY SALVARSAN.

In 1910 Ehrlich introduced a new drug for the treatment of syphilis and other diseases caused by spirochætæ. Chemically this drug is dioxydiamidoarsenobenzol, the formula being—



but it is commonly known as "606," by reason of its being the 606th such preparation which Ehrlich experimented with, or **Salvarsan,** which is the name under which it is sold. The arsenic content of the drug is 28 per cent. of its weight.

Salvarsan is the result of a long series of experiments with different highly complex organic combinations, the object of which was to discover a substance highly poisonous to the infecting organism, but only slightly harmful to the tissues of the body—in other words, a substance which was highly bacteriotropic and only slightly organotropic. In the course of these experiments Ehrlich discovered that in

many cases he could by means of continued treatment with a certain drug kill off almost all the infecting organisms (trypanosomes at this stage of the research), but that some remained which were absolutely unaffected by the drug, and these produced a race of parasite which was immune to that particular drug and which ultimately killed the animal. He attempted by the use of several of these drugs to produce *cribra therapeutica* through which none of the parasites would pass.

When he introduced Salvarsan, he advocated a process of *therapia magna sterilisans* by which one large dose was given, in the hopes that the whole of the spirochætæ would be at once destroyed by the drug, and so there would be no recurrences due to the development of a "Salvarsan immune" race of parasites. It has not been clearly established, however, that the spirochætæ ever develop an immunity to the drug, although in certain cases recurrences have been noted which were much more resistant to Salvarsan treatment (and incidentally to mercurial treatment also) than were the original lesions. The object of the treatment should be, however, to destroy the whole of the parasites with one or two large doses of the drug at the onset of the disease.

METHODS OF ADMINISTRATION OF THE DRUG.

It may be given subcutaneously, intramuscularly, or intravenously. The first two methods were used exclusively in the early stages of the employment of the drug, but they have almost entirely been replaced by the intravenous method.

The advantages of the intravenous method are—

1. The clinical results are better, more rapid, and more certain.
2. Relapses are much less frequent.
3. The injection is practically painless.
4. There is no risk of the slough at the site of inoculation provided the operation is done skilfully.

The only advantage of the intramuscular or subcutaneous method is that less technical skill is required in the injection.

The disadvantages are—

1. That great pain may follow the injection.
2. That necrosis of the tissues may occur at the site of inoculation, resulting in the formation of a sterile abscess.
3. The drug is not absorbed with the same rapidity as when inoculated into the vein, so that the action is less rapid and certain.

METHOD OF PREPARATION OF SALVARSAN FOR INJECTION.

The drug is obtained in powder form in hermetically sealed glass capsules, filled with a neutral gas. It decomposes rapidly in solution or when exposed to the air, so that it has to be made up and used immediately. The powder is soluble in water, forming a strongly acid solution which is quite unfit to inject owing to its intensely irritant effect. When this solution is neutralized with alkali, the drug comes down as a thick yellow precipitate, which redissolves in excess of alkali.

Preparation of the Intramuscular Injection.—0·5 gramme of the solid substance is triturated in a sterile mortar with 19 minims of 15 per cent. sodium hydrate solution; then the volume is made up to 5 c.c. with distilled water. The injection is made deep into the gluteal muscles,

and must be made slowly to avoid tearing the muscle. Great care must be taken not to inject close to the sciatic nerve.

Preparation of the Intravenous Injection.—0·5 gramme of the solid substance is dropped on to the surface of 50 c.c. of sterile distilled water in a flask. This is gently shaken for a few minutes till solution is complete. When solution is complete, 200 c.c. of sterile salt solution (0·9 per cent.) is added, making a total volume of 250 c.c., or 50 c.c. per 0·1 gramme of Salvarsan. Then 20 per cent. NaOH solution is added with a pipette or syringe until the precipitate which forms just redissolves. The quantity required is about 0·6 c.c., and it is best to run in ½ c.c., and then after shaking add the alkali drop by drop, shaking all the time until a clear solution is obtained. The fluid is then ready for injection.

Several points are very important in this preparation:

1. All solutions and flasks must be absolutely sterile.
2. Neutralization must not be commenced before solution is quite complete.
3. Too much alkali must not be added, as in certain fatal cases pulmonary thrombosis has apparently followed a too alkaline solution.
4. The salt solution must be made from freshly distilled water, or distilled water which has been sterilized immediately after distillation, and kept free from contamination. Many of the unpleasant symptoms following intravenous injection have been shown to be due to the use of distilled water which had been exposed for some time before being sterilized.

It has been shown that distilled water on being left exposed for some days contains large numbers of bacteria. If such water be used for making up the salt solution, although this solution be sterilized before use, yet it contains large quantities of dead bacteria, which are apparently responsible in large part for unpleasant symptoms following intravenous injection, such as rigors, fever, and vomiting. Tap water must not be used, as the Salvarsan is partially precipitated by some of the salts contained in it.

ADMINISTRATION OF THE INTRAVENOUS INJECTION.

The vein selected is in almost all cases either the median basilic or the median cephalic. These are large, easy to find even when most of the other veins are obscured by fat, and are more fixed than the other veins of the arm, which, although they may be more prominent, are much less easy to puncture with a needle. A bandage is tied round the arm above the elbow to render the veins more prominent. The needle used must be sharp, else it pushes the vein on one side; and the point ought not to be too long, otherwise there is a likelihood of transfixing the vein. The calibre of the needle varies with the method employed; for whereas a comparatively wide needle must be used if gravity alone is the compelling force (unless the injection is to take an inordinately long time), a calibre only a little wider than that of an ordinary hypodermic needle suffices if one uses a syringe to force the fluid into the vein. The advantage of a small needle is that it is easier to get into the vein, especially when the latter is small, as in some women and young children. Only under very exceptional circumstances should it be necessary to cut down on the vein, and except in a few cases of young children, cutting down on a vein is merely a confession of the surgeon's want of skill.

In all cases great care must be taken that no Salvarsan solution is injected into the subcutaneous tissue around the vein, otherwise considerable pain may follow. This is obviated by allowing some blood to run back into the tube, where it is seen at a small glass window close to the needle, or by injecting some salt solution first, when pain and swelling at the site of injection show that there is a leakage around the vein.

Two methods especially are in use for administering the injection. In the first gravity forces the fluid into the vein, and it is to be recommended on account of its simplicity; while in the other, which is to be recommended for its efficiency and general applicability, a syringe is the compelling force.

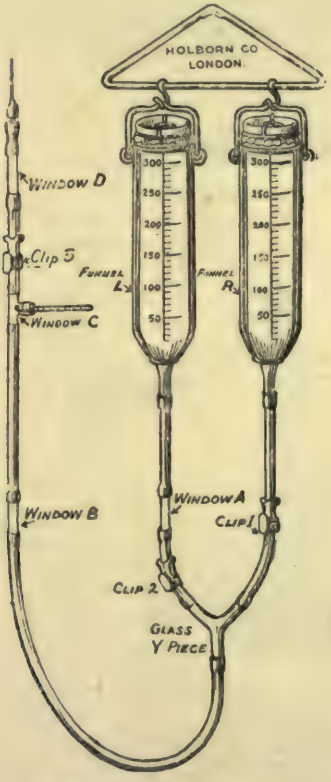


FIG. 141.—GRAVITY METHOD.

Gravity Method.—The apparatus consists of a funnel or some such receptacle leading by a tube to a needle, which is inserted into a vein. Some salt solution is first allowed to run in, and this is followed by the Salvarsan solution, and again with about 20 c.c. of salt solution.

Modifications have been devised where two funnels are attached to the needle by tubing and a Y-junction, both tubes having a clip which can be opened or shut at will.

Syringe Method.—The most convenient apparatus consists of a 20 c.c. "record" syringe, fitted with a three-way tap, one limb connected with the needle, and the other with the flasks of Salvarsan and

salt solution. The limb with the needle has let into it near the syringe a piece of wide glass tubing, and near the needle a piece of narrow glass tubing. The former serves, when held vertically with the end distal to the needle upwards, to catch any air-bubbles which would otherwise pass into the vein.

The side-limb of the tap has let into it a bulbar glass tube fitted with glass-wool to serve as a filter, and is bifurcated by means of a second three-way tap, so that it communicates with either Salvarsan or salt solution. The flasks are covered with double metal caps, with small holes for the delivery tubes, so that any contamination from the air is avoided.

The tubes are placed in the flasks, and by manipulating the taps the whole apparatus is easily filled with salt solution from the flask. The needle is inserted into the vein, and slight suction applied by the syringe till blood appears at the "window" near the needle. This is

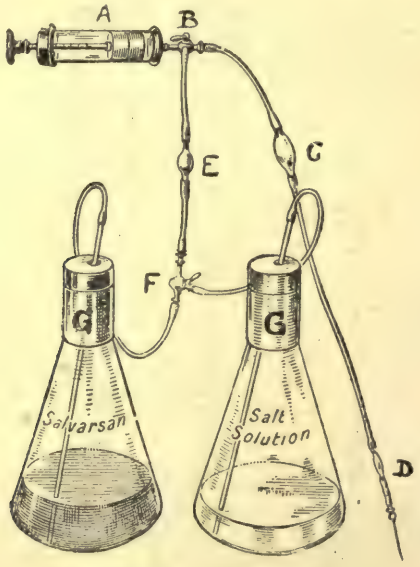


Fig. 142.—Syringe Method.

pushed back into the vein, and then the Salvarsan is injected by filling the syringe from the flask of that solution and expelling it into the vein. When the injection of Salvarsan is complete, 20 c.c. of salt solution should be injected to wash the Salvarsan out of the tubes, and to avoid any leakage around the vein when the needle is withdrawn.

For some hours before the injection the patient should not have had a heavy meal. The injection should be made in bed, and the patient should be kept in bed for twenty-four or forty-eight hours afterwards. The immediate results following injection—rigors, high fever (up to 104°), and vomiting—are now much less since freshly distilled water has been used, but they occur especially in cases of secondary syphilis. The temperature may persist for two or three days, and for some days there may be symptoms of gastro-intestinal irritation. Many patients have practically no symptoms except slight headache and malaise.

Contra-Indications.—These become fewer as the drug becomes more commonly used. Any serious affection of the heart or vascular system increases the danger of a serious result. Phthisis, diabetes, or albuminuria, is not a bar to its use.

Dangers of the Treatment.—In a certain number of cases death has followed the administration of Salvarsan in patients whose organs were apparently healthy. The cause of death was generally an acute encephalitis. In cases where the organs have been examined after death, the distribution of arsenic in the tissues is the same as it is in arsenical poisoning. In some cases the fatal result may have been due to faulty preparation of the drug, but in others it seems to be due to the patient having an idiosyncrasy for arsenic. Deafness due to paralysis of the auditory nerve, has been reported, but it is rare. In a large series of cases which I have observed none of these serious sequelæ have been seen.

Dosage.—For adult men the dose is 0·5 or 0·6 gramme, and for women 0·4 to 0·6 gramme. For a child of ten years 0·2 gramme is a suitable dose.

The best way of using the drug in, say, a case of secondary syphilis is the method recommended by the army medical authorities. An intravenous dose of Salvarsan is given, then five intramuscular injections of mercury at weekly intervals, another Salvarsan injection, five more mercurial injections, and, finally, a third dose of Salvarsan. The Wassermann reaction is taken one month after the last injection. If it is positive, the course is repeated. If it is negative, no further treatment is given, but the reaction is again taken three months, six months, and twelve months afterwards. If it is still negative twelve months after treatment, the patient may be considered cured.

EFFECT OF SALVARSAN ON SYPHILITIC LESIONS.

Primary Chancre.—In cases where spirochætes have been numerous before injection, they are not to be found twenty-four hours afterwards. The chancre clears up in a few days. Even in cases where, owing to a superadded infection, there is much inflammation or destruction of tissue at the primary seat of infection, the healing process is very rapid.

Secondary.—The roseolar rash disappears in about two days. The papular rash shows marked improvement in the same time, and by the end of a week it has practically gone. Secondary throat affections begin to clear up within twenty-four hours, and are as a rule completely healed within a week.

Tertiary.—The lesions of this stage, be they gummata, ulcers, skin affections, or bony lesions, almost all clear up with great rapidity. Of course, where there has been considerable destruction of tissue, as in a large ulcer, or where there is much necrotic material to be absorbed, as in the centre of a large gumma, some weeks have to elapse before healing is complete.

Congenital.—The skin affections which occur in early infancy clear up rapidly with one or two very small doses of Salvarsan. Many cases have been treated, with excellent results, by administering the drug to the mother of a syphilitic infant which is being breast-fed.

The later lesions of congenital syphilis are also very amenable to treatment with Salvarsan, with the exception of interstitial keratitis.

In some such cases, where the injection was given when only one eye was affected, it did not prevent the other eye becoming involved.

Parasyphilis.—In some cases of tabes dorsalis intravenous injections of Salvarsan have had a very marked beneficial effect, but seldom, if ever, has the disease been cured by this means alone. The reason of this is that when Salvarsan is injected into the blood-stream, it is rapidly absorbed by certain of the internal organs, notably the liver; but analyses of the brain substance in fatal cases have shown that none of the drug actually gets into the brain or spinal cord. Recently, however, intraspinal injections of the drug have been tried, with great benefit, in many cases of tabes and in some cases of general paralysis. The procedure is to give an intravenous injection of Salvarsan or Neosalvarsan, and then one hour after to take off from the vein about 100 c.c. of blood in a sterile manner. This blood is allowed to clot and the serum to separate. A lumbar puncture is performed, and about 30 c.c. of cerebro-spinal fluid is allowed to run out, after which the same quantity of the patient's serum (previously heated to body temperature) is slowly injected. This should be repeated three or four times, at intervals of ten to fourteen days.

Neosalvarsan.—This is a later drug which Ehrlich has introduced. It differs slightly in its chemical constitution from Salvarsan, so that when it is dissolved in distilled water it forms a neutral solution which is suitable for injection intravenously. The toxicity of this drug is about the same as Salvarsan, but the ease of solution and the fact that no neutralization of the solution is required makes it safer for general use. The usual dose of this drug is 0·9 gramme, which corresponds in arsenic weight to 0·6 gramme of Salvarsan. This quantity of Neosalvarsan can be readily dissolved in 20 c.c. of water, so that all the apparatus which is required for the injection is a 20 c.c. syringe and a sharp needle. The results of Neosalvarsan injections are the same as those described in connection with Salvarsan, except that the symptoms following the injections are seldom so marked. The therapeutic effect of Neosalvarsan is slightly less than that of Salvarsan.

Kharsivan.—This is a product chemically identical with Salvarsan, and made in England. It has been largely used since the supply of Salvarsan was cut off by the outbreak of war. It is used in exactly the same way as Salvarsan, and its effect on syphilitic lesions is certainly not less than that of Salvarsan. One or two cases have been reported, however, where an intense dermatitis followed its use.

Neokharsivan.—This bears exactly the same relation to Kharsivan that Neosalvarsan bears to Salvarsan. It is given in the same way as Neosalvarsan.

Galyl.—This is a French preparation differing somewhat from Salvarsan in that it contains Phosphorus as well as Arsenic. It is given intravenously dissolved in from 10 to 100 cubic centimetres of water. The results have been very good, and the dangers apparently are negligible.

GONORRHŒA.

An infective process due to a specific micro-organism, the gonococcus, and usually characterized by a discharge of pus from the urethra.

The organism responsible for the disease was first isolated by Neisser in 1879, and confirmed by Bumm in 1885. It is a diplococcus, staining with methylene blue, and cultivated in media containing human blood-serum or ascitic fluid, and is communicable to man and the lower animals.

Of the diseases bearing the name "venereal," gonorrhœa is perhaps best entitled to it, since, if we exclude gonorrhœal ophthalmia, it is seldom communicated except by the sexual act.

The mistake was formerly made of regarding the disease as an unimportant and local one, and curative efforts were deemed to be crowned with success when the discharge was stopped. It is now

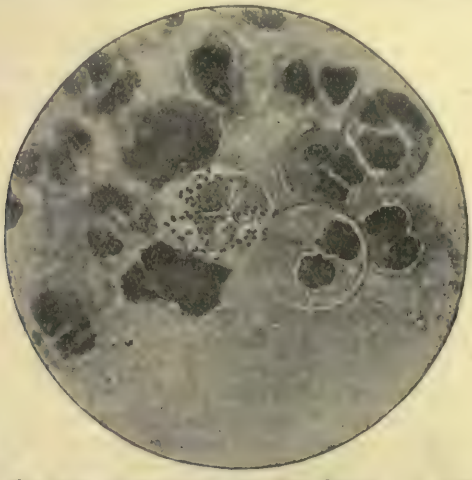


FIG. 143.—GONOCOCCI AND PUS CELLS. × 1000.
(Williams's "Bacteriology.")

known to be a serious constitutional disease, with an initial local manifestation, often leading to grave after-effects involving many tissues and organs, constituting a danger to life, and at times interfering with the power of procreation.

It would seem that men are more likely to contract the disease than women. This is probably due to the greater exposure during coitus of the mucous membrane of the urethra in man than in woman. The vaginal mucous membrane is less likely to be infected than the urethral, though that of the cervex uteri is exposed and is frequently infected. (For special gonorrhœal affections in the female, see Chapter XXXII.)

In view of the fact that two men may have contact with the same woman, and one develop gonorrhœa and the other remain free, the question may be asked, Is there anything further required to

infect than lodgment of the gonococcus within the male urethra? The answer to this is that, in all probability, the unaffected man is not liable to the particular virus. The number of such persons is, however, very small.

Erickson held the view that the most common complications of gonorrhœa, such as suppurating bubo, etc., were due to pyogenic rather than specific infection. Modern investigations, however, do not confirm this view.

The severity of the complications has no relation to the severity of the initial symptoms.

The poison is contained in the urethral discharge, subepithelial tissue, crypts of Morgagni, and glands of Littre, but not in the blood or secretions, thus differing from syphilis.

Demonstration of the Micro-Organism.—1. Take a specimen of pus from the urethra, not, however, from just within the meatus, where there are likely to be mixed organisms, which may confuse the examination.

2. Stain the film of pus with gentian violet by Gram's method, which decolourises the gonococcus. Most other diplococci retain the colour when so treated. Add a red stain (carbol-fuchsin), which will render the gonococcus easily seen.

3. The organism is demonstrated as a rounded oval body, occurring in pairs, and for the most part enclosed in pus or epithelial cells. Occasionally tetrads, and sometimes chain formations, are seen instead of the usual diplococcus formation.

A rapid method of demonstration is as follows: Take a very thin film of pus on a cover-glass, fix by passing through the flame of a spirit-lamp quickly. Float in methylene blue, wash, and mount in glycerine.

4. The gonococcus is best cultivated on media rich in albumin. The most successful medium is Wertheim's, which consists of equal parts of human serum and 2 per cent. of nutrient agar. It is difficult to cultivate, being very sensitive to temperature changes and to the reaction of the medium.

Pathology.—The organism especially attacks the mucous membrane of the genito-urinary tract, the rectum, and the eye; and most markedly those portions which are lined with cylindrical epithelium. The initial attack is a surface one, but the organism quickly finds its way down the gland-ducts, which are similarly lined, where it remains during the period of incubation, which averages three days, but may occasionally extend to thirty days. The toxin of the gonococcus, set free by the disintegration of degenerated cocci, now attacks the mucous membrane, and sets up hyperæmia and exudation of serum, and thus produces clinical signs of the disease. Owing to the exudate passing from the vessels beneath the surface, the epithelial cells become first swollen and separate, then degenerate and loose, and are finally cast off, and thus enter largely into the constituents of the discharge. If the shedding of the epithelium be excessive, the connective tissue will be laid bare, and eroded patches will result. A little later on the discharge will contain polynuclear leucocytes and some lymphocytes, derived from the vessels of the subepithelial connective tissue. Red blood-cells are also found in the discharge if the part attacked is particularly vascular. At this time the connective tissue, especially the superficial layer, becomes infiltrated with round cells, and here the organisms are found in great numbers.

The painful character of erection is due to the loss of elasticity of the

inflamed mucous membrane, so that it does not accommodate itself to the changes in size of the erectile tissue.

Thrombosis of the connective-tissue vessels and lymphangitis may occur.

The ducts of glands opening on the mucous membrane may become blocked, and so lead to accumulation within the gland of inflammatory exudate, mixed with gonococci, thus forming a gonorrhœal abscess. This is very liable to occur in the glands of Bartholin and Littré. Such a "pseudo-abscess" (Jadassohn) may continue for an indefinite period. It will thus be seen how difficult may be the eradication of the organism, as it lies *couchant* in such a position, ready to issue on the healed mucous membrane, and causes a recrudescence of the disease, or the infection of others.

When squamous-celled mucous membrane is attached, the pathological changes are not so marked, and the subepithelial connective tissue is not densely infiltrated, nor are the organisms often found in it.

A frequent manifestation of gonorrhœal poisoning is involvement of the joints and the surrounding tissues. When the synovial membrane is attacked, the endothelium is shed, and the joint is filled with a sero-purulent exudate with many pus cells and cocci. The synovial membrane is swollen and covered with granulations. Later on the cartilage may become eroded, and the periosteal covering of neighbouring bones affected. The communicating bursæ are frequently infected. If the condition does not subside, cicatricial tissue may be formed, and complete ankylosis may result. Septic arthritis sometimes occurs from a mixed infection.

The periarticular tissues may suffer rather than the articular. In that case there is a dense infiltration of the tissues with round cells, and the joint looks very much enlarged. If cicatrical tissue form in this type of the disease, the ligaments suffer most and are much weakened. Thus flat-foot may result from gonorrhœal disease of the tarsus (Pollock and Harrison).

Symptoms.—These may be divided into those of three stages—incubation, inflammatory, and chronic, which later is often preceded by a subacute stage.

The Incubation Period.—Irritation of the urethra accompanied by heat and itching. There is a slight mucous discharge from the meatus, which is swollen and red. This stage usually begins three to five days after the infective sexual act, though the interval may be much longer, and is succeeded by—

The Acute or Inflammatory Stage.—The discharge now becomes thick and abundant; it is purulent in character and greenish-yellow in colour. The act of urination is accompanied by great pain and a hot, smarting sensation. The stream of water is diminished in size. The desire to urinate is frequent, and, **owing to swelling of the urethra,** there may be retention.

Should there be involvement of the bulbous portion of the urethra—**posterior urethritis**—there will be a feeling of weight and pain in the perineum, with increased frequency of micturition and some strangury. During the whole of this period there is considerable constitutional disturbance.

Chordee is one of the most troublesome symptoms of the period; it consists of painful erections in which there is a downward twist of the penis, and occurs for the most part at night. It is due to the

interference with the entry of blood into the erectile tissue, on account of the dense infiltration, and to muscular spasm.

This period commences about a week after infection, and lasts for a fortnight, and is often succeeded by a subacute stage, which is characterized by subsidence of inflammation and diminished discharge. This lasts for four to six weeks, when, owing to lack of treatment, or sometimes in spite of it, it is followed by—

The Chronic Stage.—This is characterized by a scanty, thin discharge, which, if not properly treated, may become chronic, when it is known as **gleet.** This discharge retains its infectiveness for a prolonged period. There are no other symptoms in this stage; but if the patient takes alcohol freely or has habitual sexual intercourse, a relapse almost invariably takes place.

Desormean has shown that a true gonorrhœal gleet is caused by patches of chronically inflamed mucous membrane in the urethra, which are sometimes covered with small granulations. This condition he calls **granular urethritis.** It must be clearly understood, however, that a persistent discharge indicates a persistence of the gonococci in the urethra. The symptoms are a slight yellow discharge, gluing the lips of the urethra together. This discharge is little affected by diet, but is greatly aggravated by the sexual act. If on micturition the first few drops are passed into a separate vessel, flocculi of mucus and pus are seen floating in the urine. There is no pain or discomfort during micturition, but a few drops are retained, to dribble away afterwards as in stricture, while the stream is somewhat narrowed. Owing to the presence of the inflamed mucous patches, gleet is a fruitful source of stricture.

Gleet may in some cases be due to a chronic inflammatory discharge from the glands and mucous follicles of the urethra.

Hill has pointed out that the condition may be due to small vegetations and warts inside the meatus, and he has also shown the importance of a narrow meatus in causing a continuance of gleet.

In examining the urethra of a patient suffering from gleet, valuable information may be gained by passing an olivary-headed bougie. If an inflamed spot be present, there will be a feeling of resistance when the bougie reaches it. The endoscope is useful at this period for examining and treating the granular patches. The instrument should not be used during the acute stage, for fear of further injuring the inflamed and sensitive urethra.

Diagnosis.—What is known as the **two-glass test** is valuable for distinguishing between an anterior and posterior urethritis, and it also indicates if the attack is acute or chronic. The patient on rising in the morning passes 4 ounces of urine into one glass, and the remainder into a second one. The first glass thus contains urine from the bladder, which has washed out in its passage the anterior urethra, so that, providing it was normal when in the bladder, any pus that it contains must have come from the anterior urethra. The second glass will then be clear. If there is a posterior urethritis, both glasses will be turbid. Should there be any doubt whether the condition of the bladder itself, and not a posterior urethritis, has produced the turbidity in the second glass, the anterior urethra is washed out. The first glass will now contain the urine which has been in contact with the posterior urethra and the base of the bladder, while the second one contains the urine from the body of the bladder. If the first be turbid, posterior urethritis is indicated; if the second, cystitis.

The following table, taken from Pollock and Harrison's "Gonococcal Infections," shows the results of the test:

First Glass.	Second Glass.	Condition.
Turbid	Clear	Acute anterior urethritis.
Turbid	Turbid	Acute anterior and posterior urethritis.
Hazy	Clear	Subacute anterior urethritis.
Hazy	Hazy	Subacute anterior and posterior urethritis.
Clear, mucus and thread	Clear	Chronic anterior urethritis.
Clear, mucus and thread	Clear, mucus and thread	Chronic anterior and posterior urethritis.

When a patient has contracted a soft chancre, and phimosis results, it is sometimes a little difficult to differentiate the condition. The following four points, however, serve to distinguish gonorrhœa:

1. There is no blood in the pus.
2. The pus has a greenish-yellow colour, and is thick.
3. The possible absence of a bubo, and if present it is not necessarily suppurative.
4. Microscopic examination of the discharge reveals gonococci in large numbers.

Diagnosis has further to be made between gonorrhœa and a non-infective urethritis; while Hyde and Montgomery refer to "bastard gonorrhœa," in which only a few organisms are found in the discharge. It is probably an artificial distinction of a type of the disease occurring in individuals who have not been thoroughly cured of a former attack, and in whose urethra the organisms have lain dormant till wakened by some excess in their sexual life or their dietary. There would seem to be some reason for distinguishing such cases from an ordinary attack caused by sexual contact with the diseased, but "recurrent" would be a better definition than "bastard."

The table on p. 768, from Hyde and Montgomery's work, shows the differences in the varying types of infective and non-infective urethritis.

In addition to the above, there are certain rare forms of urethritis, the possibility of which should not be lost sight of. These are tuberculous, syphilitic, or simple bacterial urethritis.

Sometimes a drop of clear, glutinous secretion is observed at the lips of the meatus; this should not be confused with that due to a urethritis, it being merely the secretion from the glands of the urethra, owing to change in bulk of the penis from sexual excitement.

Treatment.—The treatment of gonorrhœa is both local and constitutional, and differs for the various stages of the disease. This may be divided into, general instructions and management, the administration of medicines internally, and of vaccines or other drugs hypodermically, and urethral medications.

Different schools of thought have arisen and passed away. One taught that treatment should be entirely local, another that it should be entirely constitutional, and another that it should be mixed. Still another taught that no drugs—at any rate, balsamic ones—should be given internally till after the inflammatory stage, and another that injections should not be given during the acute stage.

There has now evolved from the chaos the sane teaching that both

methods of treatment should be adopted from the outset, but that nothing should be done, either by using strong injections or otherwise, to further irritate the inflamed urethra.

Gonorrhœa.	Bastard (or Recurrent) Gonorrhœa.	Non-Infective Urethritis.
History of former attacks not necessary.	The patient has had former attacks.	History of former attacks not necessary.
The patient's general condition has no bearing on the origin of the disease, but may exert a marked influence on its course.	Enfeebled constitution is is often a factor in the production of the disease, and frequently exerts a decided influence on its course.	Enfeebled constitution is sometimes the chief factor in the production of the disease, and may even be the sole cause of its continuance.
Urethra may have been sound at time of infection.	Damaged condition of urethra necessary. Generally evidenced by gluing of lips of meatus in morning or by threads in urine. Patient may have seen no evidence of disease for months, and believed himself well.	Damaged condition of urethra not necessary, but probably present in many cases.
Cause of disease lies solely in exposure to gonorrhœal discharge.	Immediate cause usually found in sexual indulgence with or without other excesses. Occasionally other excesses are alone sufficient.	Cause found in direct mechanical or chemical violence to the urethra, often the result of too energetic treatment. In the cachectic and debilitated. Sexual and other excesses may suffice.
Period of incubation varies from one to fourteen days, rarely less than three, and usually from five to seven.	Period of incubation usually one or two days.	No period of incubation; symptoms usually appear in a few hours.
Begins with slight symptoms, which gradually increase in severity for from ten to fourteen days, when the inflammation is usually of a very high grade.	Usually subacute throughout; when more acute, the symptoms increase in severity more rapidly, but rarely become so severe as in acute gonorrhœa.	Inflammation reaches its height in a few hours.
Duration is usually from six to eight weeks. Acute stage lasts three or four weeks.	Duration very indefinite; perhaps one or more weeks. Acute stage usually lasts a week or ten days.	Acute forms usually recover in a few days, as do the subacute cases, though the latter may continue in chronic form.
Discharge contains gonococci in large number.	Gonococci usually present in small number.	No gonococci.

The General Management.—This consists in directions as to habits and diet. Unless the case is unusually acute and accompanied with great pain, the patient should not be confined to bed. It is better that he should be up and about, but with opportunity of resting on a sofa or in an easy chair, during the acute stage. Any form of violent physical exertion should be forbidden.

The diet should consist of substances which will reduce the irritating effect of the urine upon the inflamed mucous membrane to a minimum. It should therefore be diluted by taking copious draughts of milk, with an equal part of barley or soda water, and rendered less acid by natural alkaline waters. Other diluted beverages may be taken, except alcohol, which should be forbidden in any shape or form

throughout the disease. During the acute stage the diet should be largely a milk one, but cereal food, a little fish, and chicken broth, may vary it. As the stage subsides, the diet may be more general, but still very plain, all spices and acids being avoided. In the chronic stage a liberal dietary is given, still avoiding "meat dishes."

In a very marked acute form of the disease the continuous bath is of service, and may be carried out as suggested by Pollock and Harrison, by raising the sitz bath on bricks, and having a spirit-lamp burning underneath to maintain the temperature. The patient is placed in the bath with back and head resting on air-cushions, and a blanket round his shoulders and body. In such a bath he may be kept for twelve hours.

The Administration of Drugs.—In the acute stage alkaline carbonates and citrates, in the form of carbonate of magnesium, bicarbonates and citrates of sodium, potassium, or lithium, should be given, to render the urine alkaline. Morphia and atropin in the form of suppositories are useful as sedatives. The latter, according to Pollock and Harrison, also limits the extension of the infection to neighbouring parts. Hyoscyamus and buchu are of some little benefit as urinary sedatives.

The balsams and aromatic oils have a wide vogue and reputation in the treatment of gonorrhœa, which has been handed down from generation to generation. The active principles of the drugs having been absorbed into the blood, are excreted by the kidneys, and, in so far as they act as a specific on the gonococcus in the urethra outside the compressor muscle, the period of action must be more or less limited to the time of micturition. This, however, is frequent and often prolonged. These balsamic and aromatic drugs are as a rule not given till after the acute stage, because of their tendency to further irritate the mucous membrane of the urinary tract. Thus, the time when these drugs would more effectively act on the organisms before they have to any great extent penetrated below the mucous membrane is allowed to go by. A better method would seem to be to begin them at a much earlier date. The introduction of new preparations has helped to this end, as, in the old day of universal prescribing of preparations of copaiba and cubebs, the former, owing to being digested with difficulty, had often to be held over till after the acute stage, and the latter was too irritating to be given during inflammation. Oil of sandalwood is more easily digested than copaiba, and has not the over-stimulating effect of cubebs, but it is less efficacious in relieving pain in the early stages, and is liable to cause congestion of the kidneys. It is claimed, and results seem to justify the claim, that both these defects have been overcome by combining it with Kawa-Kawa. This is the root of the *Piper methysticum*, which yields two resins, which are said to have an anæsthetic effect, and to counteract the bad results of sandalwood oil. This combined preparation has been produced in a convenient form as a proprietary article under the title of *gonosan*. Each capsule contains 4½ grains, 80 per cent. of which is said to be oil of sandalwood, and 20 per cent. A and B resins of Kawa-Kawa. Proprietary articles are to be treated with a certain amount of caution. This one appears to be uniform and satisfactory in action.

Arnold Edwards advocates the administration of santyl, the salicylic acid ester of sandalwood oil, especially in acute posterior urethritis and prostatitis. It increases the acidity of the urine, and does not

upset digestion or irritate the kidneys. It does not kill the organism, but has an analgesic action.

Sanmetto in certain cases acts very well.

If copaiba be administered, it may be given as the oil in 10-minim capsules thrice daily. Oil of sandalwood may be administered in the same way and in similar doses.

The antiseptic drugs usually employed in the treatment of gonorrhœa are urotropin, salol, or boric, benzoic, and salicylic acids. Such drugs are of little or no benefit in combating the action of the micro-organism. If, however, other pyogenic organisms are present, and especially when they are in the bladder, antiseptics are most useful.

Hypodermic Medication.—This is carried out by means of **vaccines, sera,** or **colloidal preparation of silver. Vaccines** are of little use in the acute stages of gonorrhœa. Pollock and Harrison, however, believe that they may limit extension and complications. In the complications of the disease, and especially in arthritis, they are most valuable. In acute arthritis from gonococcal infection the results are often surprising in their quickness and sureness. In subacute cases the benefit is slower, owing probably to the advanced sclerosis, rendering the lymph-stream through the affected area inadequate to carry the antigonococcal substances to the organisms (Wright.) Bier's treatment is indicated in such cases in combination with the vaccines. In chronic arthritis vaccine treatment is not marked by much improvement of the condition.

Epididymitis is as a rule much benefited by vaccine treatment. It is well to begin with a small dose, say 5,000,000, and work up from that, watching the symptoms and results. As a rule the more chronic the condition, the larger is the dose required.

In the treatment of the complications of gonorrhœa, Rodgers and Torrey claimed in 1906 that they had obtained good results by injections of **antigonococcal serum** every other day in doses of 2 to 6 c.c. These results have been supported by some investigators, but on the whole the results would seem not be be so satisfactory as those obtained by the use of vaccines. Serum sickness of rather a severe nature has been reported by many observers after the use of sera in cases of gonorrhœa.

The use of **silver preparations** has recently been favourably reported on for treatment of the general infection or its complications. *Collargal* and *elektrargol* are the two substances used. The latter is less irritating than the former. Both may be used hypodermically. Collargol is also used as an inunction.

Urethral Medication—*External Applications.*—The wearing of a suspensory bandage gives some rest and relief to the parts, and is said to lessen the likelihood of the occurrence of epididymitis. Some authorities advocate hot applications, and some cold, to the penis. They give some temporary relief, but do not influence the course of the disease.

Injections.—The objection to injections is twofold: first, that in inexpert hands harm may be done by driving the infection backward and producing posterior urethritis, and even cystitis and epididymitis; and, secondly, when strong caustic materials are used, great injury is done to the urethra. Both objections can be overcome with care.

The patient should be directed to obtain a small syringe of about 4 drachms capacity. The nozzle of the syringe should be blunt and

of a cone shape, so that it does not penetrate and so irritate the urethra. About 2 drachms should be injected very gently, the penis being held behind the glans and drawn forwards to give its full capacity. After the solution has been injected, the lips of the meatus should be closed and the medicament allowed to remain in the urethra for about thirty seconds, when it should be voided. It is well to direct the patient to urinate prior to having an injection, so that the pus may be washed away.

A large number of substances have been used from time to time for injection. Some powerful germicides have found favour with certain authorities, in order that the disease might be aborted; but it is now pretty generally held that it is impossible to do this, and for the following reasons: Within a few hours of infection the gonococci penetrate beneath the mucous membrane of the urethra, and there multiply, so that if it is wished to destroy them, the patient would have to be seen at a much earlier date than is ever the case, or a chemical of such power would have to be used as would injure the mucous membrane. And even if such an unwise proceeding were adopted, the end aimed at would not be achieved, since gonococci would lurk in some undiscovered spot, and, multiplying, would perpetuate the disease in the usual way, much damage having been meantime caused to the urethra. The general consensus of opinion now points to **the use of unirritating injections** at least during the inflammatory period.

Protargol is probably the best of all injections for the ordinary case, but may prove too irritating for early use in some. It should be commenced at a strength of ¼ per cent.

Casper believes 1 per cent. solution of **thallin sulphate** to be the best unirritating injection.

Weak solutions of permanganate of potash are very servicable in some cases, and it may be used throughout the disease, gradually increasing its strength.

For the later periods, when the discharge has become thin and shows no inclination to stop altogether, and in cases of gleet, stronger solutions must be used; these may be **sulphate of zinc,** 2 grains to the ounce, or **nitrate of silver,** ¼ grain to the ounce, or **protargol,** 1 per cent.; while the granulations, if present, may be locally treated with nitrate of silver passed through the urethroscope.

The *Janet Method* is to irrigate the entire urethra by hydrostatic pressure with a weak warm solution of **permanganate of potash.** Weak solutions of silver preparations—protargol, albargin, argyrol—may be substituted.

The *Diday Method* is to irrigate with 1 per cent. solution of nitrate of silver, introduced by means of an olivary catheter inserted to the beginning of the membranous urethra, and 3 ounces passed through the urethra into the bladder; the catheter is then withdrawn as far as the bulb of the urethra, and the solution again injected.

Irrigations are said by some to be better than ordinary injections, because they are personally given by the surgeon, thoroughly wash out the urethra, and shorten the acute stage.

The method, some authorities say, should not be used till after the inflammatory period; but if properly given and a weak solution of the drug used, the method may be employed as a substitute for injection; but, on account of the apparatus and the room required, it is not likely to replace the latter, at least in private practice. Arnold

Edwards uses the irrigation of Janet in conjunction with injections of protargol, claiming that the permanganate of potash diminishes secretion and irritation, while the protargol has a direct action on the disease.

In many cases constant lavage with sterile thermal alkaline waters for long periods each day will give remarkable results. Such treatment has been carried out at Bath, and gives great promise. The patient must be watched carefully, and the length of time varied according to the result of the treatment.

Medicated bougies are sometimes used in the treatment of gonorrhœa. They were formerly made of antiseptics, such as iodoform, incorporated with oil of theobrome. They were practically useless. More recent are the bougies of Karo and Leistikow; the former is a hollow one, containing a silver salt in emulsion; the latter a bougie having Unna's paste mass for its basis, with this is incorporated whatever drug it is desired to use. Treatment by means of soluble bougies has not much vogue in this country.

Solid bougies and dilators are sometimes used with the idea of stretching the urethra and dislodging secretion.

Massage of the prostate through the rectum is sometimes carried out for the purpose of freeing the ducts of gonococci and inflammatory exudate.

Bier's Hyperæmic Treatment in Gonorrhœa.—In the acute stages it has been suggested that at intervals the penis, or preferably the penis and scrotum, should be enclosed in a specially shaped suction-glass, and pressure exerted. This might hasten a cure and prevent extension. The ordinary methods of combating the disease should meantime be kept up.

Where the **prostate** and **seminal vesicles** are affected, a rectal metal tube with a window on its concave side is used to produce hyperæmia of the affected organs. No practical results have been reported.

In **epididymitis** a rubber tube encircling the base of the scrotum or a suction glass applied to the testicles may be used. Cases have been reported in which great benefit was obtained, especially in lessening pain. When pain has subsided, the time for wearing the tube, which is given as twenty hours, should be reduced to brief periods once or twice a day, combined with hot air douches.

In subacute manifestations of the disease, such as prostatitis and epididymitis, hyperæmia is of benefit, as also in enlargement of the inguinal glands, and for absorbing deposits and infiltration.

Benefit has been obtained by suction massage of the **uterus,** and the spread of the disease upwards probably prevented.

Bier's treatment is of special benefit in acute gonorrhœal joint affections and in the chronic type; it is also of use in combination with vaccine therapy.

To sum up treatment: While different cases will require varied treatment, the following may be adopted for a typical case, and if begun early in a healthy subject, and properly carried out, will generally result in a satisfactory cure.

General Instructions.—Great care should be taken in handling the part. The discharge is infectious, and liable to cause inflammation elsewhere, especially in the eye, producing gonorrhœal ophthalmia.

The hands should be washed before and after dressing, or working with, the part. As much rest as possible, without remaining in bed,

should be taken. During the acute stage, before using an injection, urine should be passed.

Diet.—Alcoholic drinks, strong tea, coffee, and cocoa, spices, acid fruit, and red meat, should be avoided. Fish, milk, mineral and natural water, porridge, bread and butter, cheese, milk puddings, together with sweet fruits, cooked and uncooked, and certain vegetables, are allowed.

A meal should not be taken immediately before going to bed.

The bowels should be kept freely open.

Internal Medication.—At first give salines and hyoscyamus. If there is great pain and acute inflammation, morphia or atropin may be given in a mixture, or preferably in the form of a suppository. As the acute stage somewhat subsides, 10-minim capsules of sandalwood oil or of balsam of copaiba may be given, watching their effect on stomach and kidneys. Gonesan may be begun early and given throughout. If the disease spreads backwards, or is first seen when posterior urethritis has developed, santyl acts well; it is given in ½ drachm doses thrice daily. If chordee is a troublesome symptom, bromide of potassium should be given. In the chronic stage tonics, as iron and arsenic, are useful.

Local Medication.—

℞ Sol. protargol (¼ per cent.), ℥iv.

Two drachms to be carefully injected from the syringe, after urination, four to six times daily.

The strength of this injection is gradually increased up to 1 per cent. after the acute stage is passed.

Instead of protargol, permanganate of potash may be used in gradually increasing strength, beginning with 1 in 8,000; or thallin sulphate or resorcin in 1 per cent. solution, followed by sulphate of zinc, 2 grammes to the ounce, or nitrate of silver, ¼ gramme to the ounce, in the later stages.

As the silver solutions increase the discharge while diminishing the number of organisms, some authorities combine with them solutions such as permanganate of potash, which check the secretion.

Irrigations with warm solution of permanganate of potash in the acute stage, and with silver salts and zinc sulphate in the succeeding stages, may be substituted for injections.

For many of the late manifestations and complications of gonorrhœa, vaccine or Bier's hyperæmic treatment, alone or combined, is the best method.

COMPLICATIONS OF GONORRHŒA.

These may be immediate or remote; the latter have only comparatively lately been recognized as of gonorrhœal origin. The following is a summary of those most frequently met with:

Complications due to Direct Extension.—A. **Balanitis**—This is of frequent occurrence with persons who have long foreskins. It is due to pyogenic organisms. As a secondary result of inflammation of the lymphatics of the penis, an inguinal bubo may occur.

B. **Urethral or Peri-Urethral Abscess.**—This arises from inflammation of a lacuna.

C. **Retention** owing to inflamed urethra.

D. **Cowperitis.**—This is an inflammation of Cowper's glands, which

are situated in the membranous portion of the urethra, having their orifices opening into that part of the canal; it gives rise to deep suppuration in the perineum, occasioning frequent and painful micturition and painful defæcation.

E. **Prostatitis.**—As above.

F. **Vesiculitis.**—As above, together with painful emissions and priapism.

G. **Epididymitis.**—May be caused by injudicious administration of too strong injections, but usually by direct extension of the gonococci. Lumbar pain is a constant symptom, more common on the left side owing to the arrangement of the venous return.

H. **Acute Cystitis.**—By extension backwards of a posterior urethritis.

I. **Pyelitis and Nephritis.**—By extension from a bladder the site of gonorrhœal cystitis.

J. **Extension,** in the female, to the genital organs and peritoneum.

Differential Diagnosis.—

Cowperitis.	Prostatitis.	Vesiculitis.	Cystitis.
Painful emissions	None	Painful emissions	None
Slight pain on passing water	Great pain on passing water	Little pain on passing water	Intense diffused pain on passing water.
No pain on defæcation	Painful defæcation	Painful defæcation	No pain as a rule on defæcation.
No pus in urine	No pus in urine	No pus in urine	Pus in urine.
Local examination shows no enlargement	Local examination shows enlargement of prostate gland	Local examination shows enlargement of vesiculæ seminales	Local examination shows no enlargement.

Complications due to Indirect Transmission—A. **Proctitis** (in the female).

B. **Rhinitis.**

C. **Conjunctivitis:** (1) Unilateral in adults; (2) bilateral in infants (ophthalmia neonatorum).

Complications due to General Absorption—A. **Sclerotitis:** Arising quite independently of conjunctivitis.

B. **Joint Affections:** (1) Synovitis—by embolic transmission of gonococci; (2) arthritis—pyogenic as well as specific organisms are usually present.

Differential Diagnosis has to be made between acute rheumatism and gonorrhœal arthritis. The latter is not usually so painful; the swelling is sometimes due to periarticular inflammation, and therefore feels more diffuse. Fewer joints are as a rule involved. There is less rise of temperature, and the urine may contain pus and gonococci.

C. **Ligamentous** and **Muscular Tissues** may be affected, especially those constituting the arch of the foot. Flat-foot may be produced in predisposed persons.

D. **Pyæmic Abscesses** may form.

Treatment will follow general principles for the part affected. For many of the conditions, and especially for gonorrhœal joint affections, the best treatment is by vaccines infected into the joint at intervals of seven days, combined with Bier's congestive method in suitable cases.

APPENDIX

THE tuberculin vaccines are sold in various dilutions, contained in glass bulbs, but the doses are as a rule too large, and the price prohibitive, for extensive employment of the vaccines. A dilution of 1 in 10 can be made in the following way:

(*a*) Sterilize a small, narrow-necked dark bottle and a rubber cap.

(*b*) Take a bulb containing, say, $\frac{2}{2\,5\,0}$ milligramme of tubercle powder in 1 c.c., which may be reckoned at 20 instead of 18 minims, as there are two extra minims usually put in the bulb. File the tapering end and break it off; then draw up the vaccine by means of a sterile syringe, and eject it into the sterilized bottle.

(*c*) Add nine times the amount—*i.e.*, 180 minims—of sterile normal saline solution, and 1 minim pure carbolic acid to make $\frac{1}{2}$ per cent.; or carbolized salt solution (P. D. and Co.) may be used.

(*d*) The rubber cap is now drawn over the neck of the bottle, and is dipped in liquid-white wax.

We have thus got a dilution of $\frac{1}{2\,5\,0\,0}$ milligramme in each 20 minims and the dose may be taken as 1 to 10 minims, or $\frac{1}{4\,0\,0\,0\,0}$ to $\frac{1}{5\,0\,0\,0}$ milligramme. When using the vaccine, a drop of lysol is placed on the rubber cap and on the patient's skin; the needle passes through this material in drawing up the vaccine and when injecting it. As the vaccine is used, the top of the rubber cap becomes sucked in, owing to a vacuum being created in the bottle. The pressure can be equalized by injecting one or two syringefuls of air.

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